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THE
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PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

ROBERT JAMESON,

REGIUS PROFESSOR OF NATURAL HISTORY, LECTURER ON MINERALOGY, AND KEEPER OF THE MUSEUM IN THE UNIVERSITY OF EDINBURGH;

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APRIL 1845 .... OCTOBER 1845.

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ERRATA.

Page 46 (in the class Galenoides), *for* non-metallic habitus *read* metallic habitus
" 129, line 1, *for* trap *read* trass

In Vol. xxxviii. No. lxxvi. for April 1845,
Page 271, line 3 from bottom, *for* Geographical *read* Geological
" 277, line 16 from bottom, *for* on the 4th *read* as on the 4th

LIST OF PRIZES
OFFERED BY THE ROYAL SCOTTISH SOCIETY OF ARTS,
FOR SESSION 1845-46.

The Royal Scottish Society of Arts proposes to award Honorary Medals, and Pecuniary Prizes, for approved Communications.

No Prize to exceed Thirty Sovereigns.

The attention of the Fellows and of the Public is directed to Inventions, Discoveries, and Improvements in the *Mechanical* and *Chemical* Arts in General, and also to means by which the *Natural Productions* of the Country may be made more available; and, in particular, to,—

1. Inventions, Discoveries, and New Processes in the Useful Arts.

2. Inventions, Processes, or Practices from Foreign Countries, not generally known or adopted in Great Britain.

3. Notices of Processes in the Useful Arts actually practised in this Country, but not generally known.

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5. Practical Details of Public or other Undertakings of National importance,—not previously published.

6. Methods of Economising Fuel, Gas, &c.—of Preparing Superior Fuel from Peat,—of Preventing Smoke and Noxious Vapours from Manufactories,—of Warming and Ventilating Public Edifices, Private Dwellings, Ships, &c.—of Constructing Buildings on the most correct Acoustic Principles,—of Constructing Economical and Salubrious Dwellings for the Working Classes, especially in Towns,—of Gilding Brass equal in Colour to the French.

7. Inventions or Improvements in the Manufacture of Iron, and other Metals, simple or alloyed; in the Making and Tempering of Steel,—in Ornamental Metallic Casting,—in Calotype, Daguerreotype, and Electrotype,—in the Production of Artificial Light as nearly of the quality of Day-Light as possible,—in the Dissolving of Caoutchouc, and applying it to Useful Purposes,—in the Preparation of Lime and Plaster for Fresco Painting, and in appropriate Tools for laying the Plaster with precision,—in Electric, Voltaic, and Magnetic Apparatus,—in Artificial Pavements,—in Balance or Pendulum Time-keepers,—in Screw-cutting,—in Die-sinking,—in Wood-cutting, and other methods of illustrating Books to be printed with the Letter Press,—in Printing from Wood-cuts, &c.—in Printing-Presses,—in Stereotyping, and in cleaning the plaster from the Types,—in Furnaces and other Apparatus used in Stereotyping,—in Type-Founding,—in the Composition of Printers' Rollers,—in Engraving on Stone,—in the application of Daguerreotype and Calotype to the Stone for Lithographic Printing,—in Ship-building, with regard to Ventilation, both for the Crew and the Timbers,—in Currying and Tawing of Leather,—in Glass and Porcelain, whether for useful or ornamental purposes, especially for the best account of the Manufacture of Glass Pipes for conveying Water, Gas, &c.—in Stationary and Locomotive Engines,—in Railway Carriages, and particularly in their Axles,—in Railway Telegraphs and Signals,—in Smith-work and Carpentry,—in Tools, Implements, and Apparatus for the various trades. Also—

The KEITH PRIZE, value THIRTY Sovereigns,

For some important "Invention, Improvement, or Discovery, in the Useful Arts, which shall be primarily submitted to the Society."

Edinburgh, 1845.

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Dr J. Davy's Paper not yet returned from London.

ERRATUM.

Plate II., should be Plate III.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Observations, chiefly Meteorological, made at Ambleside, Westmoreland, in 1843-4-5. By JOHN DAVY, M.D., F.R.S. Lond. & Ed., Inspector-General of Army Hospitals, L.R. Communicated by the Author.

ON taking up our residence in a place new to us, the curiosity is commonly excited, and we are apt to observe with more care and minuteness, than if familiar with the scenes from living long amongst them. Under this impression, I purpose now to record some observations which I have made here during the last two years, chiefly meteorological, tending to illustrate the climate of a district in some respects peculiar, and, as I would hope, to illustrate also some phenomena of an obscure kind, respecting which there has been difference of opinion and much discussion.

Of the character of the country constituting the district, a very few words may suffice,—it is so well and generally known, as formed of a succession of valleys, but little raised above the level of the sea, bounded by hills and mountains of moderate height; and abounding in water, in lakes, tarns, and streams,—every valley having its river or rivulet, according to the extent of drainage, and almost every one its lake or lakes.

1. The effect of radiation here is often remarkable, as exhibited by a thermometer placed on the grass, or on cotton-wool, compared with another suspended in the air. I shall commence with it, as it seems deserving of particular attention, on account of its influence on the climate, and in connexion with some of its most striking peculiarities.

The following observations are examples selected from many which have been made at "The Oaks," a house situated on the skirts of the village of Ambleside, and close to the church, about 100 feet above Windermere, which latter is 140 feet above the level of the sea. It may be farther added, in regard to the locality, that the grass-plot, on which the thermometer indicating the effect of radiation was placed, is in shade till the sun is pretty high, being shaded by Wansfell, one of the higher hills of the country, rising to the eastward.

			Therm. in Air.	On Grass.	On Cotton-Wool.
			°	°	°
1843,	June 26.	2 A. M.	40	...	33
	Sept. 14.	12 P. M.	44	...	35
	... 26.	10 ...	44	38	32
	... ...	12 ...	38	33	32
	... 30.	7 A. M.	35	32	30
	Oct. 12.	8 ...	32	26	24
	... 13.	7 ...	34	27	...
	... 14.	7 ...	30	26	23
	... 16.	7 ...	25	17	...
	... 18.	7 ...	28	24	23
	... ...	12 P. M.	27	...	19
	Nov. 1.	8 A. M.	29	23	...
	Dec. 1.	11 P. M.	29	25	...
1844,	Jan. 2.	11 A. M.	26	17*	...
	... ...	4 P. M.	26	14*	...
	... ...	12 ...	20	10*	...
	Feb. 1.	9 A. M.	25	21*	...
	... 5.	9 ...	26	19*	...
	... 6.	9 ...	26	17*	...
	... 23.	8 ...	28	23	...
	... 27.	9 ...	22	13*	...
	March 5.	8 ...	27	22	...
	... 18.	7 ...	25	20	...
	... 20.	12 P. M.	28	23	...
	... 21.	8 A. M.	28	22	...
	... 28.	7 ...	32	27	...
	... 30.	7 ...	35	32	...
	... ...	12 P. M.	38	29	...
	April 1.	7 A. M.	35	31	...
	... 4.	12 P. M.	38	31	...
	... 6.	7 A. M.	40	32	...
	... ...	12 P. M.	...	29	...
	... 10.	12 ...	38	28	...
	... 27.	12 ...	38	28	...
	... 29.	12 ...	36	29	...
	May 4.	1 A. M.	45	30	...
	... 8.	12 P. M.	...	32	...
	... 26.	1 A. M.	36	31	...
	... 27.	12 P. M.	35	29	...

---

* On snow.

			Therm. in Air.	On Grass.	On Cotton-Wool.
	May 28.	12 P. M.	35°	28°	...°
	... 31.	12 ...	39	29	...
	June 1.	12 ...	40	32	...
	July 16.	12 ...	40	...	26
	Aug. 2.	12 ...	44	38	...
	... 12.	1 A. M.	...	32	...
	Sept. 22.	11 P. M.	38	32	...
	... 25.	1 A. M.	40	32	...
	... 30.	1 ...	36	32	...
	Oct. 14.	8 ...	32	30	...
	... 27.	8 ...	34	31	...
	Nov. 12.	9 ...	35	31	...
	... 22.	8 ...	31	27	...
	... 25.	8 ...	28	23	...
	Dec. 5.	8 ...	23	14	...
	... 7.	8 ...	18	11	...
	... 30.	9 ...	30	25	...
1845,	Jan. 1.	8 ...	24	20	...
	... 9.	8 ...	32	25	...
	... 30.	8 ...	22	18	...
	... 31.	9 ...	20	16	...
	Feb. 2.	9 ...	22	19	...
	... 7.	9 ...	27	24	...
	... 18.	12 P. M.	26	22	...
	Mar. 13.	8 A. M.	20	14	...
	... 14.	1 ...	19	9	...
	.. 21.	1 ...	21	11	...
	April 3.	8 ...	38	29	...
	... 6.	1 ...	31	21	...
	... ...	8 ...	37	27	...
	... 9.	11 P. M.	35	28	...
	... 11.	12 ...	32	26	...
	... 17.	1 A. M.	35	28	...
	... 20.	1 ...	38	31	..
	... 23.	1 ...	38	28	...

In all these instances of marked reduction of temperature, in connection with radiation, the qualities of atmosphere, of course, were such as are favourable to radiation, namely, a clear and calm state of air, such as accompanies the finest weather, and is characteristic of it. A clouded atmosphere, as is well known, is incompatible with it;—cloud or mist, not only acting as a screen,—but also as a radiating surface, returning to the earth a great part of the heat which it receives. The difference of temperature here in December 1843, and of the same month in 1844, displays this in a very striking manner. The one, the former, was singularly mild; spring flowers were then appearing; the blackbird had begun his song; the thermometer was never below 32°, commonly between 50° and 45°; the streams were about 6° higher than in the preceding October; and only on one night was there hoar-frost, that of the 1st. The weather, excepting this last mentioned night, was almost uninterruptedly gloomy; there were only four days in which there were partial gleams of sunshine; and it was almost uninterruptedly calm; and the little wind that there was, was chiefly from the W. and SW. The last December was unusually cold; frost set in on the 5th, and continued with little interruption the whole month; without snow, and with little or no wind, and a good part of the time with a clear atmosphere; hoar-frost appearing not only at night frequently, but often continuing and increasing in the shade by day, and that sometimes so copiously, as to have the appearance of a fall of snow. I may mention another instance, displaying the same effect in the course of a very few hours. On the 30th of March, at 1 A.M., with a clear calm atmosphere, a thermometer placed on the grass, on which was hoar-frost, fell from 34° (which it was when suspended in the air above the spot) to 28°; seven hours later, when the sky had become obscured by mist, and a very fine rain was falling, so small as hardly to be visible, the thermometer in the same situation shewed that the grass had become as many degrees warmer than the air as before it was colder; on the grass it now stood at 44°, in the air at 38°.

The observations I have given show, that almost throughout the year, hardly a month excepted, the temperature here, in connection with radiation, is occasionally reduced to or below the freezing point. And this is in accordance with the common experience of the natives, the best informed and most observant of whom have told me, that hoar-frost (the criterion of such a reduction of temperature) is not unusual even in the height of summer in fine weather.

A marked peculiarity of the climate of the lake district is, that whilst the range of the thermometer throughout the year is not great,—less, I believe, than in London or in the midland counties,—the daily vicissitudes are considerable, owing very much to the sudden changes of atmosphere, promoting or preventing radiation. One hour, under a screening cloud, the temperature may rise at night several degrees above the freezing-point, and the next, the cloud having passed away, the sky having become very clear, it may fall as many below that point. Within a few hours, it is not uncommon to experience almost every variety of weather; a frost may suddenly succeed rain, and freeze it; the thawing snow be arrested, and converted into a surface of ice; thawing and freezing alternating with the passing clouds. This last winter, drops of ice were several times seen hanging from the leaves of evergreens,—frozen drops of rain; and, once, the leaves, after a slight rain, followed by a clear sky and frost, were covered with a varnish of transparent ice, of sufficient thickness to admit of separation, and when separated, as it readily was, bearing not only the exact form, but also a perfect impression of the leaf, as a cast, shewing its most delicate fibres. Farther, in exemplification of the sudden atmospheric changes to which this climate is liable, I may mention a circumstance related to me by a distinguished individual, whose poetry has rendered this country classical, and imparted to it surely an enduring interest. He and his sister, in a winter afternoon, made a call on a family in one of the adjoining valleys. The sky was obscured when they entered the house; there was a little fog, or it may have been drizzling rain. Their visit was short, it might have been of ten minutes; on coming out, they found the ground covered with ice, so slippery and dangerous, that they considered it necessary, after going a little way, to stop at a hamlet and get the village shoemaker "to sharp" their shoes, that is, put nails into them, before they could venture to proceed home.

Owing to the same influence—radiation, considerable differences of temperature are often perceptible here in going from one spot to another, even in the course of a few minutes. I may notice some instances. On the 20th of March, when the atmosphere was very clear and calm, shortly after sunset, a thermometer in the air in a meadow, in the lower part of the valley of Ambleside, stood at 26°, and placed on the grass fell to 18°. Ascending immediately to a field only a few minutes walk, about thirty feet higher, the thermometer in the air was 28°, and on the grass 25°. On a low parapet wall, about twelve feet from a house in the same field, it rose to 31°; and on the ground, which was not frozen, close to the wall of the house, it rose to 32·5. Nowhere is the effect of a wall, especially of a southern wall, more strikingly displayed than in this country, in the prevention of hoar-frost, and in shielding tender plants from sudden reduction of temperature, the consequence of radiation. And the same remark is applicable to rocks and trees, especially the dark Scotch fir and yew tree, with their thick umbrageous mass of foliage, and also to the sides of hills of moderate elevation, compared with the valleys below. The natives, taught by experience the difference, almost invariably, in selecting a site for their dwellings, avoid the latter, giving the preference to the former. The hillside in early spring, in accordance with what has just been stated, commonly shews signs of active vegetation before the lower meadows; and also in winter, in fine weather, such as promotes radiation. In December last, the contrast was striking between the fresh green of the hill pastures, and the sad withered hue of the bottom meadows, when not covered and whitened with hoar-frost, as they very frequently were. I would add, that, to the gardener and florist in this district, and, indeed, in our climate generally, the importance of attending to the influence of radiation cannot be too much insisted on. To be convinced of this, it is only necessary to go out on a still clear night into a garden, and observe the condition of plants in different situations as to exposure and protection. I may give an instance in farther illustration. Here, at "the Oaks," on the night of the 5th of April, which was beautifully serene, after a warm day, hoar-frost was to be seen at an early hour on the grass-plot, where fully exposed; but none near trees or walls. At one o'clock A.M., a thermometer on the grass, in an exposed situation, stood at 21°; and in the air, about 4 feet above, at 31°; on a garden border, within a foot of a stone-wall, it stood at 33°; against the wall, at 35°; on the grass, under a yew tree, at 35°; in the air, under it, at the same; and in a cavity of the trunk of the tree, about 2 inches deep, at 42°; and in a room without a fire, at 60°. Viewed in regard to protection from the influence of radiation, there was reason, it must be admitted, in the old style of laying out gardens, and especially in terraces; the trimly cut hedge, the formally cut yew tree, the intersecting alleys, all conduced not only to break the force of the blast, but also to keep the temperature of the air, and especially of the ground, and of the plants themselves, above the freezing-point in the critical time of early vegetation; and whilst thus protecting, obstructing as little as possible sunshine.

2. A curious and rather rare phenomenon, that of ground-ice, or a formation of ice at the bottom of streams, contrary to the ordinary law of the freezing of water at the surface, has been happily explained as an effect of radiation, it never having been known to occur, excepting under circumstances specially favourable to the radiation of heat.* As these generally are of common occurrence in the lake district, particularly as regards perfect clearness of the streams in fine weather rivalling the clearness of the atmosphere, I expected to learn that this appearance of ice is well known to the natives; but to my repeated inquiries, I always received an answer in the negative; no one, even those most familiar with the country, had, that they were aware, ever witnessed, or even heard of it. And, till this spring, my experience was similar; I had looked for it in vain. It was on the morning of the 13th of March that I first saw it, after a night, as shewn by the preceding observations, of great cold, the radiating thermometer at 3 A. M. having been so low as 14°. At 11 o'clock in the forenoon, when it was still as low as 25° in the shade, though as high as 52° in the sunshine on the grass, I examined the state of the two tributaries of the Rotha, the principal stream of the valley, and which, flowing from lakes, is almost constantly, even in the severest weather, free from ice, and that even when its parent lakes are entirely covered with ice. The tributaries, on the contrary, descending from mountain valleys, are

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* See the very valuable paper of the Rev. James Farquharson, F.R.S., on this subject, in the Phil. Trans. for 1835.

particularly liable to be frozen. The appearances that presented in Stock-gill and Scandale-gill, the two small streams in question, were remarkable and beautiful. Wherever the banks were low, and not overhung by trees, or sheltered by great masses of rock, wherever, in fact, favourable to radiation, there ground-ice was to be seen adhering to the rocks and stones, and sunken entangled broken branches, and often where the water was most rapid. In some places there was a uniform coating of ice, but more frequently the ice was in spicular crystallizations, adhering, and shooting up much in the manner of a vegetable growth,—indeed, when I first saw them, I took them for faded confervæ. The temperature of the stream where they were found was 32°;—in contact with them, in one or two instances that the water washing them was running rather slowly, it was a little lower,—a half or a quarter of a degree. In the Rotha at the same time, where there was not a particle of ice excepting at the entrance of these rivulets, and even there, no ground-ice, the temperature was 37°. It may be deserving of mention, that ground-ice did not appear in the lower part of the Scandale rivulet, below a spot where a small stream joined it from a deep field-drain, of the temperature 40°, and which raised its temperature to 33°. I may mention incidentally, that in one place in this latter stream, well exposed to sunshine, where there was much ice at the margin, and some bottom ice in the middle, trouts were to be seen actively swimming about in the ice-cold water; and at the same time the early note of the blackbird was to be heard in an adjoining clump of trees, as if both fish and bird were under influences (probably of the bright light), independent of mere temperature rousing them to exertion.

The occurrence of ground-ice I witnessed more or less for several days in the same streams and situations,—disappearing before evening, and forming again during the clear nights, —varying very much in quantity, according to the degree of clearness of the night. Till the 20th, the appearances presented by the ice were very similar to those already described. On that day, and on the following morning, a difference of form was perceived. There was more smooth ice at the bottom, and fewer radiating spicular masses ; and in very many places, even in situations where the water ran pretty rapidly, and with a ripple, there were plates of ice underneath the surface of the water,—sometimes two, sometimes three, and more in succession, of perfect transparency, separated from each other by intervening running water, and sometimes of wide extent, stretching quite across the stream. They were attached in every instance to stones, and appeared to be formed by shoots from them, in the manner of crystallizations, extending horizontally. This was visible ;—but why the spiculæ took this direction in forming, I cannot even offer a conjecture. In no instance was this unusual formation, which, I am not aware, has ever been described before, associated with the production of ice at the very bottom. When there was only one horizontal layer, that one by checking radiation from beneath, might prevent the water from freezing there. When there were two or more layers, no doubt, the lowest was formed first. The lowest was always firmest ; that nearest the surface least so, and most crystalline, often in disjointed laminæ. There was also on both these mornings, in the shallower parts of the stream, and at their margins, a large quantity of white honey-comb ice, formed of delicate thin plates, variously intersecting, which seemed to owe its origin to the same cause as the ground-ice, and to rise from beneath the surface of the water, resting and attached to stones, and above its surface (which it was in some places to the extent of two or three inches), owing to crystallization and attraction of the capillary kind, the water being drawn up by the laminæ as they formed, and congealing in the act, much in the same manner as crystals are seen to form on the necks of bottles holding certain saline solutions.

After the 21st, the extraordinary cold weather terminated. During the day the sky became overcast ; the temperature rose to 41°, and the ground-ice rapidly vanished. During the next thirty hours there was heavy rain, 2.94 inches falling, which converted the rivulets into torrents, and swept away all traces of ice. On the 23d, in the afternoon, the temperature of the air was 55° ; that of the streams was singularly changed ; the tributaries very much swollen by the mild rain were 48°; whilst the Rotha, which, during the frost, we have seen, was many degrees higher than them, was now lower, varying in temperature from 40° to 45°, according to its distance from the lakes out of which it flowed. This is a subject to which I may recur.

I have mentioned in describing the ground-ice, the effect of a little warm stream, brought by a deep drain into Scandale-gill, preventing the formation of this ice. Is not this effect interesting and worthy of attention, as tending to illustrate how draining, at the same time that it increases the fertility of land, promotes its warmth, and that of the incumbent air and its dryness, warming, too, the river which it feeds, and that in a graduated manner, as from a reservoir? I may add a few thermometrical observations in confirmation. On the 13th of March, when the little stream mentioned was 42°, another flowing from an ill-drained field, partly marshy, was 35°; and whilst the marshy part of this field was frozen, the dry grass, at its roots, in the well-drained field, was 35°; the air at the time being 33°. And, besides the cold occasioned by a surface of ice, it should be remembered, that even after the ice has disappeared, the stagnant water, in the act of evaporating, will have on the ground, and on the atmosphere, a cooling influence.

3. Another phenomenon somewhat akin to ground-ice, viz., icicles from the projecting ledges of rocks, and sheets of ice on their slopes, as it were miniature glaciers, are, as might be expected, of common occurrence in these valleys, presenting often a very beautiful appearance. I need hardly observe, that their production is intimately connected with the circumstances favouring radiation, especially the clear sky, with thawing in the sunshine, and freezing in the shade.

That these valleys were once the site of enormous glaciers, almost comparable with any now existing amongst the Alps, is strongly indicated, by the worn rounded surfaces of the lower hills and rocks; by the well-marked grooves and scratches on the latter; by accumulations of debris, resembling moraines; and by great moved masses of rock, in situations where they could hardly have fallen, having the character of erratic masses, and in many instances marked like the rocks *in situ*. And, reflecting on the frequent low temperature of the climate almost every month in the year, as already noticed, occasionally near or below the freezing point, owing to radiation, how easy is it to conceive that this district might once have been a glacier region; all that seems necessary, being the more frequent occurrence of that state of atmosphere favouring radiation, viz., finer seasons, clearer and calmer skies, greater heat by day from more powerful and frequent sunshine, and greater and more constant cold at night from increased radiation of heat. Such a state of atmosphere might have existed with a greater elevation of mountains; and that they once were greatly higher, is clearly denoted by the enormous quantity of detritus accumulated on their lower slopes and in the valleys. Mountains, and a clear state of atmosphere favouring radiation, seem to each other generally in the relation of cause and effect; the former acting as refrigeratories, condensing the aqueous vapour, and, whilst occasioning heavy rains, preventing a loaded, damp, saturated state of air. The effect referred to, is shewn in a striking manner in this district, by comparing the quantities of rain that fall amongst the mountains in approaching them, and at a distance from them, as lately determined by means of the many rain-gauges under observation, in different parts of Westmoreland, and of the adjoining counties. Thus, in 1843, whilst 58 inches fell at Kendal, the fall at Bowness was 60 inches, at Troutbeck 64, at Esthwaite 73, and at Grasmere 90; and descending, on the other side, at Keswick 60, and at Whitehaven 46.

Farther, as shewing, even now, a tendency to glacier formation, I may notice the state of the several lakes and tarns connected with Windermere, as observed in the middle of March last, when in Westmoreland, as in England and Scotland generally, and, indeed, over a great part of Europe, the weather was unusually severe. Windermere on the 16th, 17th, and 18th of the month, when the particular observations I am about to describe were made, was free from ice; its temperature, even in shallow parts, was then about 37°. Windermere receives the river Rotha, which flows out of Rydal lake, at the distance of about two miles. The Rotha, too was free from ice; its temperature, about midway on the 16th, was 35°; close to Rydal lake it was 38°. The lower part of this lake, from whence the Rotha issued, was frozen over; the upper and larger portion of it was free from ice. It receives a stream, which may be called the upper Rotha, from the larger and deeper lake of Grasmere; the space between the two being about half-a-mile. This river, too, was free from ice; its temperature was about 37°, 38°; and the latter, even within a few feet of its outlet, flowing from under ice. Being deeper than Rydal lake, Grasmere is commonly less readily frozen; but now it was an exception, almost the whole of it was frozen, and the ice was so thick as to bear, all but a small upper portion, and that far from the deepest, where the principal stream that feeds it enters. The temperature of this stream was 36° just where it enters the lake. Here, it was tolerably free from ice, a little appearing only at its margin, where its course was not rapid. This river, which may still be considered as the Rotha, is formed by the junction of two rivulets, one descending from Dunmail Raise, and the other through Easedale, in part from the tarn of the same name. Both beyond their junction were a good deal encumbered with ice; but the former was least so, where it flows out of Easedale tarn, which is higher, by six or seven hundred feet, than Grasmere; and which, at the time, was so completely and strongly frozen, that I walked straight across it. The water, flowing at its outlet from under the thick ice—thick to its very margin where it met the water—was 36°, ascertained standing on the ice itself; and a few feet lower, where confined by rocks and running rapidly (that coming from the depth of the tarn, and from near the ice, being mixed), was 37°, 38°. The small mountain stream that fed this tarn, and which descended from another five or six hundred feet higher, ran under ice; it was heard, but not seen. Breaking through its protecting covering, its temperature was found to be 35°. Ascending to the higher tarn, Codále tarn, it, as might be expected, presented itself in the same frozen state as Easedale tarn, with its small feeder vaulted with ice. This, just before its entrance, was found to be 33°; whilst the little stream, that flowed out, was 35°, flowing from under the thick ice; but just at its exit, not itself covered with ice. The air, at the time, was 30°. These observations require but little comment. I may briefly remark, that in the gradual increase of ice, and the reduction of the temperature of the streams in ascending, the tendency appears to glacier formation, to which I have alluded; and, indeed, the higher tarn may be considered as an approach to a mer de glace; seeing that the water running into it was only 1° above the freezing-point, and that flowing out only 3° above that point, and about 4° or 5° below that of water of its maximum density.

That Grasmere should have been almost entirely frozen at this time, whilst the adjoining shallow lake of Rydal was in great part open, I apprehend is to be accounted for, in connection with the property peculiar to water, of being at its greatest density at about 40°,—the latter lake having for several weeks previously been supplied chiefly with the deep water flowing from the former, little rain having fallen, and comparatively little snow,—the whole quantity at Ambleside, as measured by the rain-gauge during the preceding six weeks, having been only 3.425 inches, of which .745 inch was in snow. The country people, struck with the contrast between the two lakes, accustomed to see the shallower first frozen, attributed the difference to an erroneous cause, viz., to Rydal Lake being less agitated by the wind; I say erroneous, for even granting that it was more disturbed, of which there is no proof, surely the opposite effect from the agitation might rather have been expected,—a greater reduction of temperature, and a quicker freezing. To those who have given any attention to the subject, it is hardly necessary to observe, that there is no difficulty in explaining the more common occurrence of Rydal Lake freezing first. As soon as its water is reduced to 40°, the first sharp frost must have that effect; and the heavy rains of the beginning of winter are often nearly as cold as this, not to insist on its constant tendency to this temperature, owing to its connection with the lake of Grasmere.

I have already mentioned the sudden change of temperature of the tributaries of the Rotha, on the breaking up of the frost on the 21st of March, owing to copious mild rain, and the comparatively little change of the temperature of the Rotha itself, with the intention of reverting to the subject. This I shall now very briefly do. It has been stated already, that when the lower part of Rydal Lake was frozen over, and the greater portion of Grasmere, that the water which flowed from under the ice forming the Rotha was about 40°, whilst that which entered the Lake of Grasmere was 36°. The day after the heavy fall of rain, I examined these lakes, and the water entering and running out of them. The flowing out water was 41° where coldest; the flowing in water about 48°; and the surface water of each lake about 47°, though only the day before covered with thick ice; differences of temperature in accordance with what might be expected, keeping in mind the peculiar property of water as to density in connection with temperature, owing to which, when brought to 40°, it will sink and tend to run out, and if of higher temperature, as was the rain-water in this instance, to float and spread over the surface. In agreement with this, streams not flowing from lakes should have their temperature more suddenly raised by warm rains than rivers from lakes, and be subject to greater vicissitudes of temperature, both which I have always found to be the case. May it not be owing to these circumstances, that fish, especially the trout, quits the lake and enters the river when flooded, and returns to the lake as the river subsides, especially in spring, when in good condition and highly fed, and at a distance from the spawning season? I believe it will generally be found, that the warmest rivers are the first which afford sport to the angler, and that in his choice he may often with profit be guided by the thermometer.

4. The appearance of dew is generally considered as connected with, and dependent on, radiation, owing to which the moisture in the air, existing in the state of transparent vapour, is precipitated on the grass, and other objects on which the dew appears, these being colder than the air. Many times I have observed what may be considered as an exception to this rule—the appearance of dew on the grass, when a thermometer laid on it stood higher than when suspended

in the air. Thus, on the 1st of September 1843, at 11 o'clock at night, the sky being overcast after a warm day, when the grass was very wet with dew, a thermometer laid on it rose to 60°; and above it, in the air, fell to 58°. An hour after, with the same state of sky, and the grass even more loaded with moisture, the thermometer placed towards the roots of the grass rose to 62°; and at its top, where covered with dew, fell to 58°. A glass-tumbler, placed at the same time on the grass-plot inverted, on its inside was copiously bedewed, whilst its outside remained quite dry. Does not this shew, that the moisture precipitated rose from the damp warm ground, through the medium of the air immediately in contact, warmed and saturated by it? And, in this instance, was not the dew produced after the manner that fog is commonly produced? I shall give another example. On the 14th of the same month, at 8 A.M., when the grass was loaded with dew, the air was 55°; the wet surface of grass, 58°; the roots, 63°. At this time a mist prevailed, and obscured the sun. I could give from my notes many other instances of the like kind, in which the higher temperature of the grass on which dew was deposited, was accompanied by a hazy or foggy state of the atmosphere. They occurred chiefly in the autumnal months, and in the early winter, the season of fog, when the Rotha, and especially lakes, and rivers running out of lakes, are commonly warmer than the air at night, and calms are frequent.

5. Hoar-frost, as it is well known, is the representation of dew, commonly appearing when the radiating surface on which it collects is below the freezing-point; nevertheless, I have sometimes found the temperature of dew at or below the freezing-point, without being frozen. This I witnessed on the 29th of March last year, and on the 4th and 7th of April at night, when the thermometer on the grass was 29°, 32°, 30°. In the first instance, it was observed at 12 at night, when the air was very calm as well as clear; observed an hour later, the thermometer on the grass had fallen to 27, and the dew was frozen. It may be conjectured, that the dew in this and the like instances was precipitated at a temperature a little above the freezing-point; and that it remained unfrozen,

owing to the great stillness of the air, after its temperature had been reduced below the point of congelation, much after the manner of water confined in small tubes at rest, on which, without freezing, the temperature has been brought as low as 20° and 17°.

6. Fog, though most generally produced under the circumstances above mentioned, sometimes appears under the contrary circumstances; that is, when the air is warmer than the surface over which it is incumbent, or comes in contact with, whether of water or rock. In the instance of mountain tops, the observation is of the oldest. Homer speaks of the moist south wind wrapping the mountains in mist. The approach of the same wind at Constantinople is known by the appearance of a low bank of mist on the sea of Marmora, the waters of which are considerably colder than the Mediterranean. Instances of the same kind have been observed over some of the great rivers of America. I may notice a particular instance which I witnessed here on the 6th of last January. It was about ten o'clock in the morning, after heavy rain, when the air was 47° and very moist, and the temperature of Grasmere and Rydal lakes at or near the freezing point, the latter having been almost entirely frozen during the preceding month, and the former in part. Whilst the mid-air was pretty clear, the mountains and many of the higher hills were hid in mist, and a distinct low mist was seen spread over a good part of the two lakes, variously figured. Over Rydal Lake, nearly in its middle, it had assumed the figure of the cross, from the intersection of two streaks. It was almost a perfect calm; the mist, indeed, here and there, was in slight motion, whilst the water was unruffled, and it continued no longer than it was calm; shortly a gentle breeze sprung up, and the mist from the surface of the lakes was immediately dissipated.

7. In conclusion, I shall notice briefly a few other peculiarities of climate of the lake district. Though a larger quantity of rain falls here than in most parts of England, yet the number of rainy days is not proportionably great; the showers are heavy, and occur about as often by night as by day. The following numbers shew this, being a statement of the

whole quantity of rain that fell in Ambleside last year, and distinguishing in what portion of the twenty-four hours it fell:—

	After Sunrise.	After Sunset.	Partly by day, partly by night.	Total Quantity.
January....	5 times.	6 times.	8 times.	7.42 inches.
February ..	7 ...	6 ...	9 ...	5.70 ...
March......	5 ...	10 ...	3 ...	7.99 ...
April........	6 ...	6 ...	3 ...	3.17 ...
May.........	2 ...	2 ...	... ...	0.13 ...
June.........	5 ...	3 ...	11 ...	4.23 ...
July.........	9 ...	2 ...	5 ...	4.24 ...
August.....	10 ...	11 ...	... ...	5.35 ...
September	2 ...	2 ...	6 ...	6.60 ...
October.....	8 ...	7 ...	5 ...	7.20 ...
November	6 ...	3 ...	8 ...	4.75 ...
December	2 ...	3 ...	... ...	1.30 ...
	67 times.	61 times.	58 times.	58.08 inches.

Though so much rain falls here, and water is so abundant, the atmosphere of the lake district is not to be considered a damp one,—rather moderately dry; seldom very dry; seldom very humid,—which may be owing, as before observed, to the mountainous character of the country, tending to condense watery vapours (the same cause that produces the excess of rain), and partly to the mountain declivities, occasioning a rapid descent of the rain water into the river courses, and partly also to the nature of the soil, little retentive of moisture, in a remarkable manner free from clay, porous and stony, especially of the valleys and of the lower hills, those which are cultivated and inhabited,—freed from peat-moss, and more or less drained. Owing to those peculiarities of country and ground, the quantity of water discharged by any stream marvellously varies, even in short intervals of time. After absence of rain for many days, it may be reduced to the smallest rivulet, which a child can step across, and, after a few hours of heavy rain, be an overflowing and wasting torrent. In less than twelve hours, three inches of rain have fallen in Grasmere; and, in a short time, I have seen the adjoining valley of Easedale flooded, the effect of the descent of some thirty or forty torrents, which, rapidly carrying off the water from the hills, have exhausted themselves, whilst the valley still remained under water. And here, I may remark incidentally, that, in consequence of this inequality of the streams of the district, there seems no probability that they can be made available, excepting on a small scale, as a mechanical power; and that there is little ground, therefore, to fear that the quietude of these valleys will ever be disturbed by extensive manufactory enterprise, or their beauty injured by the erection of the formal, incongruous buildings, which such enterprise requires.

It may be noticed, too, as contrary to what might be expected in a hilly country, liable to heavy rains and to sudden and considerable changes of temperature, that the atmosphere is seldom disturbed by electrical phenomena. Thunder-storms here are of rare occurrence, as are also hail-storms. During the last two years, on referring to my notes, I find mention of thunder only three times, on the 8th of July, the 17th of August, 1843, and on the 6th of September 1844; and each time not severe. Not a single house or building, that I have heard of, is provided with a conductor, and no instance, that I can learn, has occurred, of a building of any kind having been struck by lightning; and I have made inquiry on this point of master masons, extensively employed, to whom, were an accident from lightning to take place, it would be sure to be known.

Though thunder-storms are so rare here, yet high winds are rather of common occurrence, and storms of destructive violence are not rare. During the short period under consideration, three such have taken place, the effects of which have been witnessed in the prostration of some of the largest trees of this neighbourhood. Indeed, it is probably chiefly owing to the violence of the winds, with the little depth of soil, that this country possesses few trees of large growth, such as constitute the pride and beauty of our midland counties, and which in tame situations almost compensate for the bolder features imparted by rock and mountain. Fortunately—and it is a happy peculiarity—high winds, in these valleys, are very rarely, indeed, of low temperature. They are very seldom below the freezing-point; a circumstance to which the comparative mildness of the winter climate of the district is probably owing. It is remarkable what a change of temperature takes place at night, with a serene sky, as soon as the atmosphere has its stillness disturbed by wind. I could mention many instances in illustration, but one must suffice. At 11 o'clock at night, on the 11th of last month (April), when the air was still, as well as clear, the thermometer suspended in the air was at 35°, and on the grass 28°. Two hours after, a moderate breeze having sprung up, the thermometer on the grass had risen to 36°, and in the air to 38°, the sky remaining clear, excepting in two or three spots, which were obscured by dark-grey clouds.

8. It would be out of place here to speak of the beauty of the Lake District,—"its staple,"—with which its climate, productive of

> "Clouds, mists, streams, watery rocks, and emerald turf,"

happily harmonizes, and that in all seasons of the year, varying constantly, and imparting variety, and almost, may I say, ceaseless novelty and interest, to the face of nature,—so powerfully and charmingly reflected in the poetry of Mr Wordsworth. But, apart from considerations of this kind, the climate of this district seems to me to be recommended by circumstances connected with health and comfort, especially to one who has been scorched by tropical heats, and is familiar with the annoyances of a southern climate. Here the nights, even in summer, are always cool; and heat is seldom oppressive by day, even in the height of summer. The air is commonly to the feel pure, and fresh, and invigorating; and the torment from insects within doors is unknown, as well as all fear from malaria from exposure, even after nightfall.

THE OAKS, AMBLESIDE, *May* 1. 1845.

On the Unity of the Human Species. By M. MARCEL DE SERRES.

When we follow the progress of the sciences, and compare them with the facts contained in the most ancient of existing books, presented by religion to the respect of nations, we are struck with their uniform agreement with all this Book teaches us. It seems as if God permitted man to make discoveries, and bring his knowledge to perfection, only for the purpose of confirming the truth of the Sacred Writings. The observation of natural phenomena, moreover, cannot lead us to conclusions opposed to the faith. The truth requires the most brilliant lights to be shed upon it, in order that it may shine with all its lustre ; it cannot, accordingly, reject them, as they are calculated to render it more obvious to every eye.

Among the facts recorded in the Bible, there is one connected with the foundations of our belief, which has not yet been demonstrated in a manner sufficient to solve the doubts it has produced in certain minds,—I refer to the unity of the human species. This delicate question of natural philosophy has, at all periods, occupied the attention, not only of savants properly so called, but also of philosophers, historians, and philologists.

The solution of this question appeared, to some authors, so clear, and so contrary to the accounts given in Scripture, that Voltaire has not hesitated to assert, that none but one that was blind could admit that the Whites, the Negroes, the Chinese, the Hottentots, the Laplanders, the Americans, and, finally, Albinos, are men of the same species, and have a common origin.

It is true that all persons of candour now know with how little consideration, and, it may even be added, with what a degree of ignorance, this otherwise eminent man judged of questions of the most momentous and eternal importance. Not less than a century, however, has been necessary to overturn and destroy all the systems and assertions which Voltaire and the philosophers of his day had accumulated against religion, and particularly against the Sacred Writings. Thanks to its all-powerful influence, aided by the progress of knowledge. truth has at last triumphed. New lights have recently been shed on the question of the origin of the human species; and it is these new facts that we are about to explain to those who seek the truth in sincerity.

The identity of the human species has been attempted to be demonstrated by two different methods. The first, which was partially pointed out by Buffon, consists in directing attention to the circumstance, that species very different from each other avoid sexual connection, while those that are very nearly allied produce steril mules by crossing. The diverse races of one and the same species can alone have offspring capable of as indefinite reproduction as their parents. In other words, species remote from each other can neither reproduce nor perpetuate themselves; nearly allied species may be productive, but they cannot perpetuate their race; the most diverse *races* both reproduce and perpetuate themselves.

If we apply these facts to the varieties of the human species, we are led to the conclusion that they form only one true species; for the most dissimilar races of men give birth, by crossing, to individuals who transmit their own qualities to their descendants. The European colonies in America present all possible examples of crossing in different degrees, the effects of which render this conclusion obvious.

By the second method, that of Blumenbach, we arrive at the same results. On a great number of animals, whether wild or domestic, we may produce very considerable variations under the influence of external agents. These are, in many cases, much greater than those which distinguish the most dissimilar human races.

The observations of modern naturalists have thrown a flood of light on these questions, by shewing the influence which climate, and a return to a free state, exercise on the races of animals,—first subjected to the empire of man in Europe, then exported to America, and allowed to run wild in the vast savannahs of the New World. In this point of view, the labours of M. Roulin possess a high degree of importance, and ought to be classed in the first rank.

In order to explain the variations which man has undergone, these observers have thought it necessary to establish a much greater number of races than had been previously admitted. They have even subdivided the principal of these races, that is to say, the White or Circassian, the Yellow or Mongolian, the Black or Negro, and, finally, the Red or American. We shall not follow them in their researches, but confine ourselves to a single observation on this point. This great variety, which recently observed facts compel us to recognise in the human species, is a striking proof of the number of transitions which unite them, and the difficulty of separating them by precise characters. We may perceive in it a new proof of the impossibility of admitting the parcelling out of the human race into many species.

It is the same with the physiological differences existing between the principal races; although real, these differences are less essential than they at first sight appeared. In fact, the medium duration of life is nearly the same among all the races, because they are affected by the same diseases, and their functions operate in the same manner. If some slight differences exist among them, they are easily explained by the prolonged influence of climate and habits.

No doubt the contrasts between the modes of life of different nations appear, at first view, very great; but if we look to the motives of their actions, and their exterior manifestations, in races the most distinct, we shall find that they are nearly the same. The necessity for preservation, and the desire of happiness, are as universal as the knowledge, or, at least, the idea, of a superior power, or a God. All nations, even the most degraded, have their fêtes, their ceremonies, and a respect, more or less profound, for the dead. In general, the means of carrying their acts into execution are more diversified than the motives which cause them. These considerations, as well as a multitude of others which might be easily added, are still further proofs of the unity of the human species.

We might believe even in more numerous variations, when we consider that man possesses a wonderful faculty, *intelligence*, of which the brain appears to be the material organ. Such, however, is not the case, notwithstanding the immense progress which civilization has made among certain nations, and the development of the encephalon, which is the consequence of it. We know that this organ implicates the exterior forms in its movements, and that these express its variations.

According to this new consideration, the modifications of the human species should be dependent on the material organ of intelligence. Accordingly, among the inferior races of men, the more the brain is exercised, the nearer man approaches the White race; when, on the contrary, he is deprived of the blessings of civilization, his nervous system is under the sway of his other parts. Greatly altered in a physical point of view, man becomes, in some measure, assimilated to the brutes, from which he is so far removed by his type and his future destiny.

A great portion of the human species has thus descended in the scale of life. It is to this departure from the primordial type that we owe those innumerable races, the lowest of which cannot be recognised by those who seek for some traits of the primitive beauty of man. A new experiment is in progress on the American continent, which will soon enable us to perceive the causes of all these alterations. The Negroes, who, up to our times, had never united themselves into a nation, nor possessed a regular form of government, have all of a sudden made surprising improvements in these respects, and are advancing with rapid steps, in the New World, to the possession of that knowledge which is now concentrated in the heart of Europe.

In proportion as intellectual labour causes the vital energy to predominate in the head, men of deeply coloured complexion, with crisped or woolly hair, or with short hair, will shew an obvious tendency to approximate to the White race; they will advance along with it in the path of improvement.

The proof of this has only begun; but even now the effects are perceptible; and they will become more and more conspicuous in future, if, in consequence of the vicissitudes which are inseparable from our destiny, men of colour do not abandon the new path they have opened up for themselves. This path will become to them more plain and easy to be followed, if they connect themselves with the White race, which are their elders in civilization.

If this latter has become degenerate, in proportion as it receded from its point of departure, future ages will be furnished with the proof that certain varieties of the human race, after having been subjected to degradations more or less marked, may yet reascend, by continued intellectual efforts, to their first origin. It will not be without surprise that they shall be seen to resume the beauty of their primordial type, after having reconquered, so to speak, the intelligence, whose precious light they had allowed to be extinguished. This view, like the preceding, tends to establish the unity of the human species, and to justify us in assigning the same cradle to the most elevated as well as the most degraded of the human species.

This consideration leads us to the examination of another fact, not less important, and which arises in some measure from the preceding. If man constitutes only a single species, he must have been placed on a single point, whence he has radiated, as from a centre, and extended his tribes over the whole surface of the earth. Here history agrees with the information we obtain from the study of man, considered without reference to his primitive abode. It teaches us that Adam was created alone, with a consort; that he was placed in the centre of Asia, with the injunction to people the earth, and that his posterity have extended from this central point, the one most favourable for its dispersion over all parts of the globe where the conditions were found requisite for his existence. The study of languages, as well as that of history, leads to the same conclusion; by mutually supporting each other, philology and historical documents impart a striking character of truthfulness to this inference. It is confirmed by facts independent the one of the other; and this agreement is the most manifest proof of its justice and accuracy.

Such are some of the facts which prove that, on this question, science goes hand in hand with religion and historical traditions. In fact, all traditions represent nations as deriving their origin from a single stock, and as emanating from one individual.

The observations by means of which we have supported the beautiful opinion of the primitive unity of the human species, do not, however, demonstrate it in a direct manner. M. Flourens comes to our aid and supplies this deficiency: by a comparative study of the different structures of the human organism, he has arrived at the same result which had been reached by following another path.

He has commenced this study by an examination of the skin, considering it among the races where this organ is coloured, and among such as present no sensible colour. In the first, there is found a pigmental membrane or *pigmentum*, which is not seen in the second, except on certain parts of the body. This membrane, discovered by Ruysch in Negroes, had been considered, from the observations of that author, as characterising certain races, just as its absence distinguished others. But it is far from possessing the importance which was at first assigned to it.

The skin of a White man, by exposure to the sun, acquires a very thin layer of *pigmentum* between the second epidermis and the true skin, that is to say, in the same place as in the Negro. It may be said that the accidental coloration, produced by the sun, alters the cellular tissue and produces the pigmental substance peculiar to the coloured races. But it must be further observed, that the white man is not exempt from the common law. Even in his natural state his skin has its *pigmentum*, very inconsiderable, indeed, but still sufficiently perceptible. That part of the breast, which is named the nipple, is, as is well known, of a dark colour, in the male, and more particularly in the female of the white race. We there find a pigmental apparatus, so that this part of the skin exhibits, in the white race, the structure existing in that of the coloured races.

This membrane, connected with the coloration of the skin, is not therefore essential to the nature of the races; it cannot be considered as characterising them, since the skin of the fœtus in the negro shews not the least trace of it. So far is it from being essential, that we do not perceive the slightest indication of it in those individuals of the coloured races who are affected with partial albinism. In such cases the organ presents a great number of white spots; by the side of these spots, the skin preserves its ordinary colour, black, red, brown, or some other shade; but, what is remarkable, the points where the skin is not coloured, are destitute of the pigmental membrane.

M. Moreau de Jonnès has, in like manner, observed among the negroes of the Antilles, individuals of both sexes whose skin was spotted with white. These spots, which appear very conspicuous on the black surface of the body, are rather greyish or of a greyish-white colour, than pure white. The number of individuals in whom this appeared was very limited.

Other travellers affirm that they have witnessed similar facts in the island of Cuba, not only among the black population, but also among individuals of mixed blood. This discoloration of certain parts of the skin, in races which usually have it coloured, shews that the non-secretion of the pigmentum may be the effect of a morbid alteration, but cannot be regarded as characteristic of the different human races.

These researches will lead to certain others, of not less interest; for they are connected with the question we are now considering. According to the preceding statements, the pigmental substance disappears in all the parts of the skin which are discoloured, and remains only in those whose shades do not vary from a more or less sombre tint. Hence, individuals of the Negro race, who, by crossing with Whites, acquire tints more and more faint, ought to have the pigmentum but little developed; this organ should even almost wholly disappear, when the negro has in a great measure acquired the characters of the white race.

It would, therefore, be curious to follow the various degrees of alteration the pigmental membrane undergoes, and to ascertain whether they coincide with the varieties sprung from the Black or White races, which are commonly designated by the name of *quadroons* or *demi-quadroons*.

We wish we were in a situation to undertake these researches, which, we doubt not, would concur in establishing the identity of the human species, equally with the facts we have recounted. The lively interest this subject excites, leads us to hope that American observers, who have such facts under their eyes daily, will profit by the advantage of their position, and enlighten us on a point so important in the history of humanity.

When we compare at once, and without any intermediate series, the skin of the white man with that of the black or the red man, we are tempted to assign a distinct origin to each of these races; but if we pass from the white man to the black or the red, through all the intermediate varieties, it is no longer the difference, but the analogy, which strikes us.

The researches of which we have given an outline are far from being entirely new, but they lose nothing on that account of their merit and importance. In fact Aristotle, that great genius of ancient times, had stated, long before Camper, that the black colour of the skin in Negroes and Moors, was probably produced by the rays of the sun. This opinion, erroneous though it be, does much less violence to the truth, than the idea adopted by Pliny, on the authority of ancient writers. This naturalist mentions, as a certain fact, that the waters of a river in Thessaly had the property of staining the skin of men and animals black, and making the hair frizzle. Thus, according to him, the particular characters of certain human races had their origin in a circumstance, a belief in which nothing could authorize.

Such absurd or imperfect notions are widely removed from the present state of science; but we may perceive in them the germ of this essential fact, that the colouring matter exists more or less in all the races, and that external agents can render it more or less apparent.

The comparative anatomy of the skin affords, then, by the complete and universally prevailing analogy in the structure of this organ, a direct proof of the common origin of the human races, and of their primitive unity.

Thus, the European, with his graceful and elegant forms; the Negro, characterised at once by the colour of his skin and the peculiar contour of his head; the American Indian, with a red skin and herculean form; and, lastly, the Chinese, with a yellow tint and oblique eyes; are all derived from the same stock, and form a single chain, of which Adam constituted the first link.

Such is the solution science gives of this interesting question of the primitive unity of man; such is that which has been given in a book written upwards of 3500 years ago. Let us bow, therefore, before the Sacred Writings, in which such important knowledge is embodied; and let us not forget that, while they contain all the moral truths essential to our happiness and future destiny, they likewise present to us the greater number of the important physical facts, of which we formed no idea till after long-continued and toilsome labours.

If these researches interest our readers, we shall return to this question; and we shall make them more particularly acquainted with the works of M. Flourens on the study of the skeleton and the cranium of man. These investigations will be found to confirm a conclusion which was propounded by Moses, and, in modern times, has been adopted by the majority of physiologists, at the head of whom stand Blumenbach, Camper, and Cuvier.

We shall likewise enumerate, in detail, the researches recently undertaken with the view of resolving the doubts of natural philosophers, respecting the truth of one or the other hypothesis proposed to explain the phenomena of light. We may state beforehand, that, as the facts related by the Hebrew legislator seem more favourable to the theory of undulations than to that of emission, we doubt not that the experiments by which the means of deciding between these two opposite theories are sought for, will confirm what this extraordinary man had already announced upwards of thirty-five centuries ago.

We thus see this admirable Book acquiring greater importance from age to age, at the same time that the sciences are making new conquests. The Bible, a rich and inexhaustible mine, will send forth into the world, treasures always becoming more valuable, in proportion as the progress of our knowledge shall furnish us with more perfect instruments for drawing from its bosom the truths which the Supreme Intelligence has deposited there from the earliest period.*

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* From the *Bibliothèque Universelle de Genève*, No. 107, 1845.

On Mineralogical Classification. By Professor CARL FRIEDRICH NAUMANN.

All mineralogists are probably agreed, that mineralogical *species* are to be regarded as the proper object of every classification. They represent the units which are to be grouped in some way or other, in order that a well arranged general view of the mineral kingdom may be obtained; they furnish the individual building stones, by whose union is to be erected the edifice which is to receive the name of a mineralogical system, without, however, a building plan having hitherto been proposed which satisfies all demands. This has probably arisen, on the one hand, from the difficulty of arranging the amorphous mineral species among the crystalline species, and on the other, from the one-sidedness which has caused mineralogists, as well as chemists, to err in their attempts at classification.

Few mineralogists doubt that *amorphous* possess just as good a right as *crystalline* substances to be arranged in classifications of the mineral kingdom. The views of mineralogists differ, however, as to whether amorphous substances are to be arranged along with crystalline species, as they are in Mohs' system, or, as Fuchs proposes, they should only be appended as pseudo-species, or, as has partly taken place in Breithaupt's arrangement, they should be grouped together in a separate order.

Some mineralogists, biassed by the old oryctognostical prejudice, that the so-called external characters are alone of value in the *characteristic* and *classification* of minerals, have, owing to their not sufficiently appreciating the invaluable results of chemical investigation, endeavoured to establish mineralogical systems, which must necessarily be rejected by chemists, because they collect together in the same order, nay, even in the same genus, minerals of the most heterogeneous constitution, merely from their agreeing in this or that morphological or physical character. On the other hand, chemists have also attempted to form mineralogical systems, which have never received the approbation of mineralogists, because, by undervaluing the peculiarities impressed on the whole physiognomy of the physical individual, they have, from the mere presence of this or that ingredient, united minerals in groups, which cannot by any possibility be satisfactory in a physiographical point of view.

A middle course must therefore be sought for, which, by avoiding, on the one hand, self-sufficient oryctognostical, and, on the other, exclusive chemical one-sidedness, may escape the reefs on which all those mineral systems have been wrecked, that have been founded either entirely on external physiognomy, or entirely on the presence of certain component parts. Among chemists, Leopold Gmelin was the first in Germany who attempted this middle path; and it is generally acknowledged that his mineralogical system has been much more successful than the previous purely chemical attempts of the same kind. In 1828, I published an elementary work on Mineralogy, in which I endeavoured to adhere as much as possible to the principles laid down and followed by Gmelin. The arrangement, however, then attempted of two hundred species could not make any claim to the term mineralogical system. At a later period Glocker published his Elements of Mineralogy, in which are contained very many and extremely successful combinations, founded on similar principles; and these, together with the classifications of Weiss and Breithaupt, previously partially made known, proved that the principle of the mixed system is capable of yielding very satisfactory groups. More recently, Whewell, in his History of the Inductive Sciences, has critically examined the fundamental principles of the mineralogical systems previously published, and has triumphantly proved, that a *mixed system* alone can satisfy the requirements of physiography.

Impressed with the correctness of this view, and encouraged by the favourable opinion expressed by Whewell in regard to my first effort, I now venture to present to the public a mineralogical arrangement, which, although founded essentially on the same principles as my first attempt, must yet lead to somewhat different results.

Every attempt at a mineralogical classification ought to start with the question, What idea is to be regarded as the actual guiding principle of that intellectual operation, whose result we term a mineralogical system? Now, as the idea of *identity* is exhausted in the determination of *species*, it is only the idea of *resemblance* which can form our proper guide in all operations of classification.

The resemblance, however, of two things, is their greater or less agreement in certain prominent characters; and it can neither be founded on *all* their characters, nor on their *complete* agreement, because, otherwise, it would coincide with the idea of identity. It must rather be regarded as, in its very nature, somewhat fluctuating, and susceptible of various gradations; it is recognizable sometimes in one, and sometimes in another character, sometimes in a higher, and sometimes in a lower degree.

Hence it results that, in every classification founded on the idea of resemblance, we must commence with the investigation,—*What are the essential characters in which resemblance is especially to be sought for and regarded?* Or, in other words, and with particular reference to the question now before us, *What value* is to be assigned to the various properties of minerals, as regards the requirements of a systematic arrangement? In answering this question, we arrive at the result, that it is the *resemblance of inorganic masses, without* reference to their *form*, which must *especially* be kept in view in mineralogical classification.

Morphological properties.—In establishing species, morphological properties occupy the first rank; for amorphous and crystalline minerals can never be united in one and the same species, and in crystalline minerals, relative identity of crystallographic form, that is to say, the belonging to the forms of one and the same crystallographic series, with a similar character in the combinations, is to be considered as the first requisite of specific identity. It is entirely different, however, with the *systematic arrangement* of species. Calcareous spar and arragonite, a rhombohedral and a rhombic species, approach each other so nearly, that, in a mineralogical system, they must follow each other as closely as possible. The same is the case with the three species of iron pyrites, with vesuvian and garnet, and with rutile and Brookite, although these substances are separated from each other by their entirely different crystallographic systems. We thus arrive at the conclusion, that great *difference* in morphological properties may be united with great *resemblance* of the *mass;* a result which is strikingly evident in most *dimorphous* substances.

On the other hand, a glance at mineralogical arrangements formed according to crystallographic systems, teaches us, that great resemblance, and even identity, in morphological properties, may exist along with the most remarkable difference in the mass. Hence it evidently results, that morphological properties can only receive a *subordinate* degree of attention in a mineralogical *systematic arrangement;* and that although the distinction of the *amorphous* and *crystalline* nature of the substance be attended to, yet that scarcely any importance is to be assigned to the distinction of *crystallographic systems*. Mineral systems, founded on crystallographic forms, have, in fact, only a *crystallographic* but no *physiographical* interest; because such systems sometimes bring together the most dissimilar substances, and at other times place the most similar minerals far apart. When similar *masses* also exhibit similar forms, the matter is much facilitated, and the groups to which they belong are rendered much more distinct by such an agreement. This is the case, for example, with the felspar group, and with the hornblende and augite group.

As, therefore, in a classification of mineral species, the *morphological* properties perform only a very *subordinate* part, it is self-evident that those *physical* properties which are directly connected with, and dependent on, the crystallographic form, must receive just as little consideration; this is especially the case in regard to cleavage, the refraction and polarization of light, &c.; and thus, while cleavage is a character of first-rate importance for *specification,* it is of but small moment for *classification.* If, for example, we attempt to unite all the mineral species having a very perfect monotomus cleavage, as, indeed, has been partly done, we shall find the most dissimilar minerals placed together in *one* order, although *some* of its groups, as, for example, the micas, exhibit, along with similar cleavage, a similarity of the mass. It is unnecessary to explain, that a classification founded on the *crystallographic indications* of the cleavage planes, would coincide with an arrangement founded on crystallographic systems, and would have just as little physiographical value.

It therefore results, from what has been said, that it is the *formless masses*, or, that it is the *masses without reference to the form*, which must in reality form the immediate object of every general arrangement of mineral species. Hence we must entirely give up the morphological and morphological-physical properties, and thus gain the great advantage, that all the varieties of a species, the perfectly crystallized, as well as the crystalline, the isolated fully developed individual, as well as massive and compact aggregates, will receive *equal* consideration. This feature gives rise to a striking distinction between inorganic and organic nature, for, in the latter, classification is, and must be, founded on the resemblance of the morphological *habitus*.

If, however, the inorganic *mass*, *without* reference to its form, is to be regarded as the true principal object in the systematic arrangement of mineral species; and if, accordingly, morphological properties, and the physical properties directly connected with them, can only in certain cases throw into the scale an accessory, and, so to speak, a superfluous weight, it is self-evident, that, in the determination of physiographical resemblance, it is only *certain physical properties*, and the *chemical properties* represented by chemical constitution, which can receive consideration.

We must above all assign a great degree of importance to the distinction of the *metallic habitus*, for its characters can be recognised at the first glance. Opacity, metallic colour, and metallic lustre, the three characters whose union produces that appearance which we designate by the expression "metallic habitus," can be perceived and recognised with equal certainty in the smallest particle, and in the largest mass of a mineral; so that we can instantaneously determine with great confidence whether a mineral possesses the metallic habitus or not. Now, as the presence or absence of the metallic habitus stands in intimate connection with the whole nature of the mineral species, the greatest care must be taken in the arrangement of mineral species, that metallic and non-metallic species should not be promiscuously mixed together. Hence, if it should appear most proper to assign to the native metals, as the true representatives of the mineral kingdom, a place in the middle of the whole series, then those mineral species which are provided with a metallic habitus, without being simple metals, must naturally be placed immediately *before and after* the metals.

With reference to the *colour* of minerals, it has already been included as one of the characters of the metallic *habitus*. With respect, however, to non-metallic minerals, it is not so much the quality or particular nature of the colour, as the general distinction of the *coloured* and *tinged* condition* which is to be attended to; because there are many mineral species which, agreeing also in their other properties, exhibit in common the character of being *coloured, i. e.*, of possessing a colour essentially inherent in their substance and hence appearing of a like quality in all their varieties; we have examples of this in red lead spar, blue copper, malachite, &c. In a mineralogical arrangement, therefore, we must be careful to keep the *coloured non-metallic* species as much as possible together, and to associate with them only such *colourless* (or tinged) species as possess other properties, which justify or render necessary such a union. As, moreover, the same mineral species exhibit a coloured streak, and as the very similarity of the colour of their streak and of their mass, may be regarded as a criterion of their coloured nature, it is also necessary to notice the value of the streak in mineralogical classification.

In regard to *lustre*, its *kind* or *quality*, no doubt, possesses a certain degree of importance, in so far as the true metallic lustre is a requisite of the metallic *habitus*, which is so worthy of attention in classification. Apart from this consideration, however, the quality of the lustre is of *no* essential importance, as is rendered evident by the circumstance, that not unfrequently crystals reflect different kinds of lustre from their different faces, and from the fact, that *certain* modifications of lustre arise rather from the state of aggregation than from the mass itself. It is self-evident, that the *intensity* of the lustre, which is dependent on the nature of the surface, is still less deserving of general attention.

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* See my *Lehrbuch der Mineralogie*, p. 124.

Pellucidity, which is susceptible of so many gradations from transparency to opacity, must be taken into consideration, not according to its degree, but with reference to its being present, because the opposite of pellucidity, viz., opacity, is a character of the metallic *habitus*. Hence we must avoid, as much as possible, intermixing pellucid and opaque minerals; and exceptions to this rule are only to be admitted in special cases.*

Hardness and *specific gravity*, two properties which perform so important a part in the determination of species, also deserve proper attention in *classification*. As, however, they admit only of *quantitative* and not of qualitative distinctions; as in respect to them, the *similarity* of two mineral species can only be sought for in the presence of gradations approaching each other very nearly, or at least not at all remotely; and as an absolute determination and comparison of such gradations is not afforded to us, more especially in the case of the hardness; we can only state, generally, that, in each group, there must not be too strikingly different degrees of hardness and too great a variation in the specific gravity, although even here, and, more particularly, in regard to the hardness, there may be special exceptions, when there is agreement in more important properties. Much greater attention is due to specific gravity than to hardness, because the uncertainties connected with the former, are fewer in number and smaller in amount, and because its

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* Connected with this point, the occurrence of what is termed the splintery fracture is a character deserving of attention, because it always indicates to us the presence of pellucidity, even when the latter is only perceptible as a feeble translucency in the thinnest splinters. Opaque minerals never admit of our *recognising* the splintery fracture, even though it should actually be present.

greater differences stand in intimate connection with the important distinction of heavy and light metals.

Tenacity and the *quality of the coherence* are certainly properties which belong to the very essence of the masses. As, however, the differences in regard to these properties are distributed in very unequal proportions throughout the species of minerals; as malleability and even sectility are rare, in comparison with the very predominating brittleness; and as, moreover, the determination of these properties is more or less dependent on the state of aggregation of the mineral; the importance of these characters for classification is diminished, without, however, being entirely neutralized.

Magnetism, *i. e.*, the power of acting on the magnetic needle, is a singular character, but occurs in too few species to admit of its being employed in classification. The same may be said of the *electrical* phenomena of minerals, although the conducting power, at least, is not altogether to be rejected.

The *chemical* properties, and particularly the chemical constitution of mineral species, must occupy a very prominent position in a classification which has for its object essentially the formless masses. They represent the very material itself; that substratum which forms the basis of all morphological and physical phenomena, and which is scientifically expressed by the formula of chemical constitution. How would it then be possible to produce an arrangement of minerals consonant with nature, without especial regard being paid to this foundation of their very being, this really causal portion of their whole phenomena? If we test some of our mineral systems founded nominally on mere external characters, we soon arrive at the conviction, that many of their groups have been formed only by means of an involuntary consideration of the results of chemical analysis; while some of the other groups in which this was *not* the case, and in whose formation every exertion has actually been made to renounce all chemical reminiscences, the most strange and unnatural unions are presented.

It has always been my conviction that mineralogy robs itself of its most beautiful and interesting portion, and that it of itself obtrudes a *testimonium paupertatis* which it ought to disdain, when, mistaking entirely its actual position as a branch of natural history, and, dazzled by the phantom of a supposed higher independent rank, it does homage to the old oryctognostical prejudice, that assistance is to be derived from external characters alone: as if *all* the properties had not their foundation in the *nature* of the minerals; and as if some of them, like garments, belonged to their exterior, and others to their essential constitution. Neither the variety of names of the sciences, by whose assistance we recognise and determine the properties, nor the greater or less delicacy of the procedure required, nor the distinction whether we must merely scratch, file, split, and break the mineral, or also heat, fuse, and dissolve it, can justify us in having exclusive regard to *certain* properties, while others of the highest importance are neglected. This holds good in the classification of minerals, as well as in the determination of species, and hence we believe that chemical composition must be brought prominently forward, as one of the essential guides in every arrangement.

We should, however, never forget, that the idea of *resemblance* must remain as the *fundamental principle* of our arrangement, in *whatever* properties we may have to seek for this resemblance. We shall thus avoid the objections with which we must charge those mineral systems where *identity of composition* is the leading idea, and where the minerals are arranged either according to the series of the electro-positive, or according to the series of the electro-negative elements. How little, in all cases, resemblance is founded on identity of composition, is rendered so distinctly apparent by the allotropy (*allotropie*) of the elements themselves, and by the dissimilarity of their isomeric combinations, that all proofs of the assertion would be quite superfluous. Diamond and coal are in reality two entirely different bodies, notwithstanding the identity of their composition; and the same holds good in the case of calcareous spar and arragonite, in that of rutile and Brookite, and with regard to many other examples of allotropic elements, and isomeric combinations. Hence, composition *alone* by no means produces similarity or dissimilarity, and the final result of chemical investigation may prove to us a perfect *identity*, where the entire morphological and physical properties irresistibly demand the recognition of the most decided *diversity*.

A classification founded on identity of composition, undoubtedly approaches its object much more nearly when the arrangement is based on the *electro-negative* elements, than when it is founded on the electro-positive, because the former have generally a much more decided influence on the internal nature and external physiognomy of the combinations than the latter. This method, however, is also so unsatisfactory in its results, that we are necessarily induced to consider chemical resemblance from a somewhat different and more general point of view, constant regard being paid to the physical resemblance of the mass.

It is obvious that we must, in the first place, place apart and arrange as much as possible together, all the *elements themselves* which are presented to us as free products of nature in the mineral kingdom; for it is, indeed, the *elementary condition* which gives rise to their general *chemical* resemblance. These elements, however, have partly a metallic and partly a *non*-metallic *habitus*, and hence require to be arranged in different regions of the mineral kingdom. The metals claim the centre of the whole series; while the non-metallic elements, such as carbon and sulphur, must be placed elsewhere. Some metallic combinations must be placed close to the metals, and must, therefore, be arranged along with them in a proper manner.

The natural metallic oxides and some of their combinations are in part provided with the metallic *habitus;* they have a considerable specific gravity, are generally coloured substances, and must accordingly be placed near the metals; we assign them a place *before* the latter, and thus, proceeding backwards, we obtain a point of junction for many of those combinations, partaking of the nature of salts, in which the same metallic oxides occur as bases, or at least, are frequently substituted for other isomorphous bases. On the other side of the metals, we place the sulphur, tellurium, arsenic, and selenium combinations, which may be grouped together in three very natural orders, viz., glances, pyrites, and blendes.

In regard to all *combinations partaking of the nature of salts* (with the exception of what are termed sulphur-salts, and the like), the distinction of *heavy* and *light* metals and their oxides seems to be of the highest importance, as has been acknowledged by Hauy and Beudant, and more prominently brought forward by Gmelin. We must, more particularly, make this distinction available in regard to the silicates and the other salts containing oxygen, in so far as we must divide these, according to this difference of their bases, into *metallic* and *non-metallic* silicates and salts. Double salts, with bases of *both* kinds, or those salts in which the oxides of the light metals are frequently, and in a great measure, replaced by oxides of the heavy metals, may be considered as *amphoteric* salts.

The silicates, and the aluminates which approach them so nearly, are distinguished in so remarkable a manner from all the other combinations of the mineral kingdom partaking of the nature of salts,, that they must necessarily be arranged in a *separate* group.

The distinction of the *hydrous* and *anhydrous* condition, must be particularly attended to in classification, not only because it can be ascertained by a very simple experiment, but also, because, in most cases, it is intimately connected with the whole *habitus*, and with the mode of formation of the mineral.

Guided by these and similar principles, I submit to the indulgent criticism of mineralogists and chemists, the following attempt to arrange the mineral kingdom in series. As this arrangement is neither based solely on chemical, nor solely on physical, properties, but on *both* kinds of properties taken *together*, it must naturally happen, that sometimes the one set of properties, and sometimes the other, must receive a predominant degree of attention, according as the physical habitus or the chemical constitution may seem to possess greater weight in the determination.

The importance assigned to solubility in water, by founding on that character alone two separate classes, will not be much approved of by chemists, but is scarcely to be avoided in a physiographical point of view, because, without employing this character, the placing of various species (such as sassoline, the nitrates, &c.), would have given rise to great difficulties. Besides, as the chemical examination of minerals always begins with the determination of their solubility or insolubility in water; we have, at least, a practical argument for retaining the Hydrolites, a class which, it must be confessed, cannot in other respects be altogether vindicated.

It has been necessary to designate the greater sub-divisions by particular names, in order that they may be expressed with facility and brevity. The selection of these names was attended with no small difficulty. I have borrowed some of them from Glocker, and I place no value on the other names proposed; but, on the contrary, I am desirous that other and better designations should be suggested.

SYSTEMATIC ARRANGEMENT OF MINERAL SPECIES.

General Synopsis.

Class	I.	Oxide of Hydrogen.	
...	II.	Hydrolites,	Hydrous Anhydrous.
...	III.	Chalcohydrolites,	Anhydrous, Hydrous.
...	IV.	Chalcohaloides,	Hydrous, Anhydrous.
...	V.	Lithohaloides,	Anhydrous, Hydrous.
...	VI.	Geolites,	Hydrous, Anhydrous.
...	VII.	Amphoterolites,	Anhydrous, Hydrous.
...	VIII.	Chalcolites,	Hydrous, Anhydrous.
...	IX.	Metallic Oxides,	Hydrous, Anhydrous.
...	X.	Metals.	
...	XI.	Galenoides or Glances.	
...	XII.	Pyritoides or Pyrites.	
...	XIII.	Cinnabarites or Blendes.	
...	XIV.	Thiolites.	
...	XV.	Anthracides.	
...	XVI.	Asphaltides.	

Synopsis of the Species arranged according to the Classes and their subordinate divisions.

CLASS I. OXIDE OF HYDROGEN.—Water and ice are such peculiar members of the mineral kingdom, that they must necessarily be separated from all other minerals, and be placed in an independent class,

Water. Ice.

CLASS II. HYDROLITES.—Acids, oxygen-salts and haloide-salts with *earthy* or *alkaline* bases, which are either wholly, or in a great measure, soluble in water, and hence impart a distinct taste to the tongue.

Order I. Hydrous Hydrolites.—Sassoline (Boracic acid), Tinkal (Borax), Trona, Urao, Natron, Glauber salt, Mascagnine, Ammonia-alum, Potash-alum, Soda-alum, Hair-salt, Epsom-salt, Polyhalite, Lime-saltpetre.

Order II. Anhydrous Hydrolites.—Potash-saltpetre, Soda-saltpetre, Sal-ammoniac, Rock-salt, Sulphate of potash, Thenardite, Glauberite.

CLASS III. CHALCOHYDROLITES.—Acids, oxygen salts and haloide-salts with *metallic* radicals of the bases or acids, which are wholly, or in a great measure, soluble in water, and impart a distinct taste to the tongue.

Order I. Anhydrous Chalcohydrolites.—Arsenious acid.

Order II. Hydrous Chalcohydrolites. — Coquimbite, Basic sulphate of iron, Botryogene, Iron-vitriol, Copper-vitriol, Cobalt-vitriol, Zinc-vitriol.

CLASS IV. CHALCOHALOIDES.—Insoluble in water, for the most part coloured, and chiefly partaking of a saline *habitus*; in chemical constitution they present themselves as oxygen salts and haloide salts with *metallic* radicals of the prevailing bases or acids (or also of both); but all silicates and aluminates, and all titanic acid and tantalic acid combinations, are excepted.

Order I. Hydrous Chalcohaloides.

Zinc-Bloom
Aurichalcite
Malachite
Azure Copper
Brochantite
Volborthite
Atacamite
Libethenite
Phosphorchalcite
Ehlite
Olivenite
Euchroite
Liriconite
Strahlerz
Copper-Foam
Copper-Mica
Copper-Uranite
Lime-Uranite

Cube-Ore
Scorodite
Symplesite
Vivianite
Grüneisenerz
Hetepozite
Huraulite
Cacoxene
Gelbeisenerz
Iron sinter
Diadochite
Nickel-Bloom
Cobalt-Bloom
Haidingerite
Pharmacolite
Picropharmacolite
Hydrocerite
Azure-lead (cupreous sulphate of lead)

ORDER II. ANHYDROUS CHALCOHALOIDES.

Chloride of silvar
Bromide of silver
Iodurет of silver
Chloride of mercury
Cotunnite
Mendipite*
Vauquelinite
Red lead-spar
Phönikochroite (Melanochroite)
Vanadinite
Variegated lead-spar
(*a*) Mimetasite
(*b*) Pyromorphite
(*c*) Hedyphane
Sulphate of lead
Caledonite
Lanarkite
Leadhillite
Carbonate of lead (including zinc-lead-spar)
Corneous lead-spar
Yellow lead-spar
Tungstate of lead
Scheelite
Fluo-cerite
Monazite
Tryphyline
Triplite
Zwieselite
Herrerite
Zinc-spar
Manganese-spar

Sparry iron
Mesitine spar.

CLASS V. LITHOHALOIDES.—Insoluble in water, for the most part colourless, and chiefly of a *habitus* partaking of the nature of salts; in their chemical constitution, essentially oxygen salts and haloide salts, with *non*-metallic radicals of the predominating base, acid, or both; but still with the exception of all silicates and aluminates, and all combinations of titanic and tantalic acids.

ORDER I. ANHYDROUS LITHOHALOIDES.

Talkspath
Magnesite
Ankerite
Rautenspath
Gurhofian
Brown spar
Calcareous spar (including plumbo-calcite)
Arragonite
Strontianite
Witherite
Alstonite
Baryto-calcite
Boracite
Rhodizite
Cryolite
Fluor-spar
Apatite
Wagnerite
Amblygonite
Phosphate of Yttria
Celestine
Baryto-celestine
Heavy spar
Allomorphite
Anhydrite

ORDER II. HYDROUS LITHOHALOIDES.

Gypsum
Alumite
Aluminite
Hydro-magnesite
Gaylussite
Hydroboracite
Wavellite
Peganite
Lazulite
Calaite
Variscite

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* The mendipite might probably be more correctly placed among the metallic oxides.

CLASS VI. GEOLITES.—So called, because most of the minerals of a truly stony nature, and composed of earthy elements, belong to this division. Silicates and aluminates, whose predominating bases are earths and alkalies; also silica, alumina, and the other earths.*

ORDER I. HYDROUS GEOLITES.

A. *Crystalline Substances.*

- Gibbsite
- Diaspore
- Hydrargillite
- Brucite
- Nemalite
- Pyrosclerite
- Picrosmine
- Pyrallolite (?)
- Pyrophyllite
- Pholerite
- Neurolite
- Xanthophyllite
- Seybertite
- Rosellane
- Wörthite
- Okenite
- Laumonite
- Leonhardite
- Stilbite
- Desmine
- Epidesmine (Epistilbite)
- Aedelforsite
- Brewsterite
- Thomsonite
- Pectolite
- Skolezite (Lime-mesotype)
- Natrolite (Soda-mesotype)
- Mesolite
- Lehuntite
- Harmotome
  - (*a*) Lime-Harmotome
  - (*b*) Baryte-Harmotome
- Zeagonite
- Apophyllite
- Chabasite
- Gmelinite
- Phacolite
- Glottalite
- Analcime (and cuboite)
- Ittnerite
- Edingtonite
- Stellite
- Datolite
- Prehnite

B. *Amorphous Substances.*

(Many minerals of this subdivision are mere products of decomposition.)

- Chonikrite
- Kerolite
- Soapstone
- Retinalite
- Meerschaum
- Aphrodite
- *Speckstein*
- Agalmatolite
- Onkosine (?)
- *Steinmark*
- Tuesite
- Miloschine
- Bole from Stolpen
- Melopsite
- Malthacite
- Kollyrite
- Razoumoffskine
- Cimolite (including *Töpferthon*)
- Pipestone
- Kaolin
- Halloysite
- Gummite
- Schrötterite
- Allophane
- Alumocalcite
- Opal
- Chalilite
- Pitchstone
- Pearlstone

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* If the earths were to be united in a separate class, the latter would include only Gibbsite, Diaspore, Hydrargillite, Brucite, Opal, Quartz, Corundum, and Periclase. Such a class must necessarily precede the Geolites, and would cause a total transposition of the orders of the class Geolites, and of the two following classes.

Order II. Anhydous Geolites.

Obsidian
Sphærulite
Leucite
Nosean
Hauyne
Azure-stone
Cancrinite
Sodalite
Nepheline (and Elaolite)
Humboldtilite
Gehlenite
Meionite (and Scapolite)
Tabular Spar
Boltonite
Spodumene
Petalite
Anorthite
Labradorite
Oligoclase
Albite or Tetartine
Ryacolite
Glassy Felspar
Orthoclase
Porcelain Spar
Margarite
Diploite
Amphodelite
Andalusite
Chiastolite
Couzeranite
Kyanite
Sillimanite
Bucholzite
Raphilite
Weissite
Glaucolite
Bytownite
Saussurite (?)
Nephrite*
Emerald
Chrysoberyl
Euclase
Phenakite
Chondrodite
Topaz
Schorlous topaz
Zircon
Sapphirine
Periclase
Corundum
Quartz

CLASS VII. AMPHOTEROLITES.—Silicates and aluminates, whose bases are either essentially *partly earths* and alkalies, *partly metallic oxides*, or whose *earthy* bases are *often and chiefly* replaced by isomorphous metallic oxides.

Order I. Anhydrous Amphoterolites.

Dichroite
Eudialite
Spinel
Chrysolite
Axinite
Tourmaline
Helvine
Garnet
Pyrope
Vesuvian
Grenatite
Isopyre
Gadolinite
Allanite
Orthite
Titanite
Epidote
Babingtonite
Hornblende
Augite
Acmite
Hypersthene
Diallage
Bronzite
Pinite
Magnesia-Mica
Potash-Mica
Lithia-Mica
Talc
Chlorite-Spar

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* According to the recent analyses of Rammelsberg and Schaffhäutl, the nephrite approaches augite very nearly.

ORDER II. HYDROUS AMPHOTEROLITES.

A. *Crystalline Substances.*

Vermiculite
Pennine
Ripidolite
Chlorite
Anauxite
Ottrelite
Schiller-Spar
Asbestus from Reichenstein (*Chrysotil*)
Serpentine
Antigorite

Kirwanite
Karpholite
Krokydolite
Mountain-Wood
Zeuxite
Gigantolite
Fahlunite
Pyrorthite
Orthite (in part)
Thorite (?)

B. *Amorphous Substances.*

Sordawalite
Mountain-Soap
Dermatine
Plinthite (and Rhodalite)
Erinite
Pyrargillite
Bole

Fettbol
Eisensteinmark
Yellow-Earth
Glauconite
Green-Earth
Pimelite

CLASS VIII. CHALCOLITES.—Silicates and aluminates, whose predominating bases are essentially *metallic oxides;* also some combinations of tantalic and titanic acids.

ORDER I. HYDROUS CHALCOLITES.

A. *Amorphous substances.*

Wolchonskoite
Copper-Green
Copper-Blue
Chlorophaeite
Nontronite

Pinguite
Chloropal
Pea-Ore
Anthosiderite
Thraulite

B. *Crystalline substances.*

Chloromelane (Cronstedite)
Sideroschisolite
Chamoisite (?)
Black Siliceous Manganese
Pyrosmalite

Dioptase
Cerite
Bleigummi
Hydro-silicate of Zinc (Calamine)

ORDER II. ANHYDROUS CHALCOLITES.

Willemite
Hypochlorite (?)
Siliceous Manganese
Tephroite
Troostite
Siliceous Bismuth
Bustamite
Automalite

Lievrite
Knebelite
Yttrotantalite
Æschynite
Polymignite
Fergusonite
Pyrochlore

CLASS IX. METALLIC OXIDES.—Oxides of heavy metals, and such combinations of them as do not possess a salt-like *habitus.*

ORDER I. HYDROUS METALLIC OXIDES.

- Needle Iron-ore
- Lepidokrokite
- Stilpnosiderite
- Bog Iron-ore
- Brown Iron-ore
- Wad
- Groroilite
- Manganite
- Varvicite
- Psilomelane
- Cupreous Manganese
- Black Cobalt-ochre (Absolane)
- Copper-Black
- Neukirchite
- Uran-ochre
- Antimony-ochre.

ORDER II. ANHYDROUS METALLIC OXIDES.

- Bismuth-ochre
- Molybdena-ochre
- Wolfram-ochre
- Oxide of Antimony
- *Glätte*
- Minium
- *Schwerbleierz*
- Uranium Pitch-ore
- Red Zinc-ore
- Red Copper-ore
- Brookite
- Anatase
- Rutile
- Tin-ore
- Wolfram
- Tantalite
- Hausmannite
- Braunite
- Pyrolusite
- Red Iron-ore
- Titanic Iron-ore
- Franklinite
- Chromate of Iron
- Magnetic Iron-ore.

CLASS X. METALS.—Native metals, and some of their combinations.

- Iron
  - (*a*) Terrestrial
  - (*b*) Meteoric
- Iron-Platina
- Platina
- Platina-Iridium
- Iridium
- Osmiridium (2 species)
- Palladium
- Gold
- Copper
- Bismuth
- Lead
- Mercury
- Amalgam (3 species)
- Silver
- Antimonial Silver
- Antimony
- Antimonial Arsenic
- Arsenic
- Tellurium

CLASS XI. GALENOIDES (Glances).—Sulphurets, seleniurets, and telluriurets of metals, chiefly of a grey and black, rarely of a white and pinchbeck-brown colour, and of a non-metallic *habitus;* malleable or sectile; hardness reaches that of calcareous spar.

A. *Tellurium Glances.*

- Telluric Silver
- Graphic Tellurium (and *Weisserz*)
- Foliated Tellurium
- Telluric Bismuth
- Telluric Lead

B. *Selenium Glances.*

- Seleniuret of Mercury
- Seleniuret of Silver
- Seleniuret of Copper
- Eukairite
- Seleniuret of Copper and Lead
- Seleniuret of Lead

C. *Sulphur Glances.*

(*a*) *Containing chiefly Lead or Antimony.*

Lead-Glance
Steinmannite
Geokronite
Boulangerite
Embrithite
Plagionite
Bournonite
Zinkenite
Jamesonite
Feather-Ore
Berthierite
Antimony-Glance

(*b*) *Containing Molybdena.*

Molybdena-Glance.

(*c*) *Containing Bismuth.*

Bismuth-Glance
Copper-Bismuth
Needle-Ore
Bismuth-Silver-Glance

(*d*) *Containing chiefly Silver.*

Lead-Silver-Glance (*Schilfglaserz*)
Sternbergite
Eugene Glance
Silver-Glance
Melane-Glance
Copper Silver-Glance

(*e*) *Containing Copper.*

Copper-Glance
Copper-Antimony-Glance
Antimony-Copper-Glance

CLASS XII. PYRITOIDES (PYRITES).—Sulphurets and arseniurets of metals; chiefly of a yellow, white, or red, rarely of a grey or black colour; and of a metallic *habitus;* brittle; hardness for the most part greater than that of calcareous spar, and reaching that of felspar.

(*a*) *Containing principally Silver.*

Weissgültigerz.

(*b*) *Containing Copper.*

Fahlerz
Tennantite
Copper-Blende
Variegated-Copper
Copper-Pyrites
Weisskupferkies

(*c*) *Containing Tin.*

Tin Pyrites.

(*d*) *Containing Iron.*

Arseneisen (2 species)
Arsenical Pyrites
Magnetic Pyrites
Rhomboidal Iron Pyrites
Hexahedral Iron Pyrites

(*e*) *Containing Cobalt.*

Glanzkobalt (Hexahedral Cobalt Pyrites)
Speiskobalt (Octahedral Cobalt Pyrites)
Tesseral Pyrites (*Arsenkobaltkies*)
Sulphuret of Cobalt (Isometric Cobalt Pyrites)

F. *Containing Nickel.*

- *Haarkies*
- Iron Nickel-Pyrites
- Grey Nickel-Pyrites
- Red Nickel-Pyrites
- Placodine
- Bismuth Nickel-Pyrites
- Antimony Nickel-Pyrites
- Nickel-Antimony

CLASS XIII. CINNABARITES, (Blendes.)—Sulphurets of metals of a *non*-metallic, or only *semi*-metallic, *habitus*; pellucid, (with exception of manganese blende); from adamantine to pearly lustre; sectile or slightly brittle; hardness reaching that of fluor-spar; specific gravity above 3·4.

- Manganese-Blende
- Zinc-Blende
- Voltzine
- Cadmium-Blende (Greenockite)
- Antimony-Blende
- Fire-Blende
- Miargyrite
- Antimony Silver-Blende
- Arsenic Silver-Blende
- Mercury-Blende
- Red Arsenic-Blende
- Yellow Arsenic-Blende

CLASS XIV. THIOLITES.—Nearly the same may be said of sulphur as of water; it is of so peculiar a nature, that it can scarcely be arranged in any of the other classes.

- Sulphur
- Selenium-Sulphur

CLASS XV. ANTHRACIDES.—In part crystalline and of inorganic origin, and in part phytogenic, *i.e.* consisting of vegetable matter more or less decomposed and mineralized.

(*a*) *Mineral Substances.*

- Diamond,
- Graphite

(*b*) *Phytogenic Substances.*

- Anthracite
- Black Coal
- Brown Coal

CLASS XVI.—ASPHALTIDES.—Resins and organic combinations.

- Amber
- Mineral Oil
- Elaterite
- Asphaltum
- Retinite
- Ozokerite
- Scheererite
- Hatchetine*
- Idrialine
- Mellite
- Oxalite

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* From Leonhard and Bronn's *Jahrbuch für Mineralogie &c*, 1844, Heft 6. p. 641.

Note on the Vaporization of Mercury. By John Davy, M.D., F.R.S., &c. Communicated by the Author.

That mercury, at the ordinary temperature of the atmosphere, like water, is capable of existing in the state of vapour, is, I believe, now admitted. A fact has lately come under my observation, which, as an additional proof of this property of the metal, may, perhaps, be deserving of record.

In a press, from which light was excluded, and within which there was very little circulation of air, a pneumatic mercurial trough was kept, holding about 30 lbs. of quicksilver, and also a bottle of iodine, closed, but not carefully, with a glass stopper. The trough stood on an under shelf, the bottle on an upper one, one over the other, about two feet apart. After about two months that they had remained undisturbed, at a temperature ranging between 50° and 55°, having occasion to use the iodine, my attention was arrested by an efflorescence, as it were, of a brilliant red colour, consisting of minute crystals deposited on the upper rim of the neck of the bottle, not on its under, and on the stopple above, most abundant on the rim close to the stopper, gradually diminishing towards its top.

The red crystalline matter examined, was found to be biniodide of mercury; and as such, it is, of course, a proof that the metal, as before said, is capable of passing into the state of vapour at a comparatively low temperature. I did not attempt to determine the quantity of the iodide formed; from its appearance, it may be conjectured to have been at least one-tenth of a grain.

It may be well for those who work much with mercury to keep in mind this property, and guard against it, by carrying on their processes in well ventilated rooms.

The Oaks, Ambleside,
May 9. 1845.

Examination of the Views adopted by Liebig on the Nutrition of Plants. By WILLIAM SELLER, M.D., one of the Vice-Presidents of the Botanical Society of Edinburgh. Communicated by the Author.*

The onward career of analysis, from mineral nature to the study of organic bodies, has nearly broken down the barrier between Chemistry and Vegetable Physiology. The publication of Liebig's work "On the Chemistry of Agriculture and Physiology," marks an era of surpassing import in Chemical Science, as well as in the Philosophy of Plants. It is not to any unexpected novelty in its facts or principles that that work owes its excellence. It is because it discloses, in one unbroken view, the growing evidence of the unity of the operations of Nature,—because it sets the mind at ease with itself on many matters difficult of belief—because it affords the testimony of a competent judge, one of the acknowledged masters in the great art of interpreting Nature, to the reality of many unlooked for links between separate provinces in the economy of the natural world—and because it thereby prepares us patiently to contemplate relations, which, at first sight, seem too remote from the ordinary line of our thoughts to come within the compass of the human faculties, and even too daring to obtain our unqualified faith..

But Liebig's work is not a treatise whose object is to resolve points of difficulty in the economy of plants. It is rather an appeal in behalf of the trust-worthiness of certain great principles of investigation, the value of which in guiding the onward progress of physiology has been too little recognised in past times. His views turn on particular methods of inquiry as necessarily leading to the truth; while it may be feared that his propositions occasionally partake of the character of assumptions made to illustrate the application of his principles, rather than of inferences, in the exactness of which an implicit reliance can be placed.

My object at present is to examine the views adopted by

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* Read to the Society on 13th February 1845.

Liebig on the nutrition of vegetables, for the purpose of determining how far these are just, and with what limitations they require to be received.

The following propositions represent the spirit of the opinions on which I wish to comment.

1st, That the food of plants is strictly of a mineral or inorganic nature.

2d, That ammonia, carbonic acid, and water impregnated with a few saline matters, are the sole aliments of plants.

3d, That the organic matter of soils must pass into the mineral state, namely, into water with a saline impregnation, carbonic acid and ammonia, before it can become subservient to the uses of vegetation.

4th, That the saline matters and the like, which form the ashes of plants, are, without exception, taken up from the soil, and are, in no respect, the product of vegetation, as was taught in the beginning of the present century.

Thus the maxims adopted by Liebig on the nutrition of plants are of a negative character; for, if it can be shewn that the doctrine of the nutrition of plants by organic compounds in the soil is unfounded, then the truth of Liebig's grand axiom, as to the mineral nature of the food of plants, is established at once.

There are two groups of opinions to which those of Liebig stand in a negative relation, namely, those which represent the food of plants as solely or principally of an organic kind, and those again which admit the food to be inorganic in the main, yet available for nutrition only when certain azotised matters of an organic nature, derived from the soil, are present.

It is the first of these two groups of opinions only, that stands opposed in particular to what Leibig inculcates, and to this I propose to address myself chiefly; for, unless all opinions of this stamp be overthrown, it is impossible to subscribe to his doctrine.

If the food of plants be solely organic substance, then there must have been originally (or at least at one time*) in the soil a store of organic matter adequate to the development of the substance of all plants and animals, as well as to the repair of the annual waste in both organic kingdoms, from their rise down to the period of their final extinction. By the annual waste of organic substance, in both kingdoms, is to be understood the amount which passes into the mineral or inorganic state, without having acted as nourishment to plants.

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* To assume that soil was formed from the atmosphere in the course of time, by the gradual rise of the vegetable kingdom, would be to beg the

The animal kingdom is dependent exclusively on the organic matter of the vegetable kingdom for its support. Hence, it follows, that, by the hypothesis opposed to Liebig's, both organized kingdoms must be maintained at the expense of the organic matter of the soil. There are only two conditions under which this is possible; either that there is no material waste of organic matter in nature; or, what is the same thing, no conversion of it to any great extent into mineral substance, but, on the contrary, a continual circulation of organic matter, ever changing, but still preserving its organic character, from the soil to the fabric of plants, and from plants to animals, and so back, without actual loss of organic form, to the soil; or if there be necessarily much waste, that, after the original production of the two organised kingdoms to much the same extent to which they now exist, there was left in the soil a quantity of organic matter adequate to supply the annual waste from the beginning of the present system of things downwards, and in all time to come, till the extinction of the existing races of organised beings and living organisms.

But the waste of organic matter is undeniably very great over the surface of the earth. It would require a separate dissertation to explain all the various modes in which organic matter is unceasingly reduced to the mineral state.

In the single function of respiration, each mammal con-

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question, the merits of which are under consideration. The question, then, as to the formation of soil must, like the origin of organic species, be regarded as belonging not to the laws of nature, but to the origins of things, and, therefore, forbidden in inductive science. What in this inquiry is called the beginning of the present system of things, must, consequently, be considered as a state not essentially differing from that of the earth's surface at present.

sumes annually much more than its own weight of carbon, which is but one of the constituents of organic matter. Birds consume more, the less perfect animals consume less. Hence it cannot be an over-estimate to assume, that, on an average, every living creature annually destroys in respiration alone, its own weight of the carbon of organic compounds. In insects, the consumption of oxygen, which is a near measure of the carbonic acid thrown out in respiration, is as great compared with their weight as in mammals; and the quantity destroyed by mammals, in proportion to their weight, is nearly the mean between the greater amount consumed by birds, and the less amount required for the respiration of cold-blooded animals in general. The objection of Berzelius, that the carbon consumed in respiration is overrated, because it is more than equal to the whole carbon in the average amount of food, plainly involves an over-estimate of the average proportion of water, and an under-estimate of the average proportion of carbon, in the diet of men; he makes the water three-fourths of the weight, and the carbon one-half of the remainder, which is true of only a few articles of food.

A second great source of the conversion of organic matter into carbonic acid is the burning of wood in fires, of lamp-oil, of tallow and wax in candles, of cotton and rushes for wicks, and of other such vegetable and animal substances in domestic life. Thus the means of keeping himself warm, of cooking his victuals, and of supplying himself with light in the absence of the sun,—conveniences not voluntarily dispensed with by any individual of the millions of the human race—involve a daily consumption of much organic matter all over the globe, except in the few localities in which a supply of heat and light, in the shape of coal, is afforded from the organic remains of a former world. Of the quantity of wood destroyed in common fires, one may judge from the fact, that Great Britain, containing less than a fiftieth part of mankind, at a moderate calculation, consumes annually, besides peat and wood, 20,000,000 of tons of coal, 17,000,000 of which are reckoned to be for mere domestic use. Accidental conflagrations, and the too frequent ravages of war, in houses, ships, forests, and the like, swell the amount of waste by fire. A candle which lasts for an evening, destroys between 1 and 2 ounces of carbon. Hence, in the 250,000,000 of families which make up the great family of the human race, the nightly consumption of tallow, oil, or the like, must amount to many millions of pounds.

Some crops are raised to be burned; so that the whole, or nearly the whole, annual produce would be so much loss to the organic matter of the general soil. Of this kind are tobacco, kelp, and barilla.

In the process of fermentation, by which wine, beer, spirits, and vinegar, are produced, a large quantity of organic matter is reduced to the mineral state, and that without denying the name of organic compounds to the wine, beer, alcohol, and vinegar, formed in the mean time. How enormous, then, must have been the total loss of organic matter in this way since the time when the secret of converting the juice of the grape into wine was first discovered. To the waste caused in this way should be added that which takes place daily by the formation of carbonic acid, in making fermented bread.

But the loss by these last sources of destruction are as nothing compared with that which takes place everywhere, but particularly in cities, by the complete decomposition of numerous animal and vegetable substances, the refuse of both organic kingdoms, when that refuse fails to be collected and applied to its proper use, as manure to the soil. How little of the organic matter conveyed from every great town to the adjacent sea or river escapes complete decomposition! The product of all our fisheries can make but a small reduction on the amount of this loss. How much of such organic matter is carried away annually from the soil itself by rivers, to become incorporated with the deposits that are ever forming at their confluence with the sea.

All the numerous articles of furniture, clothes, and equipment in general use, composed of linen, woollen, cotton, straw, leather, furs, hair, horn, bone, and ivory, by the hypothesis denied by Liebig, draw their origin exclusively from the organic matter of the soil; and whatever part of these undergoes complete decomposition, or fails to return to the soil without the loss of its organic character, would be so much withdrawn from the original stock of organic matter, provided against the demands of the two living kingdoms of nature during their continuance. Many such substances are designedly destroyed, to a great extent, to furnish compounds of cyanogen and ammonia. Other sources of this kind of destruction will readily suggest themselves to every one. I will, therefore, content myself with adding one more, namely, the hourly destruction in the article of paper; how little of the miles of paper daily manufactured in the United Kingdom returns to the soil undecomposed!

Thus, on the hypothesis of organic matter being the sole food of plants, there must have been from these and other sources of transformation an enormous annual diminution of the quantity of organic substances in the soil ever since the commencement of the present system of things; and it follows irresistibly that the two living kingdoms of nature could endure no longer than while the primitive store should withstand this annual demand upon it. Hence, if the truth of this hypothesis could be established, we should have a principle, the application of which, as soon as some precision can be imparted to the data, would bring out the exact period after which the present system of organic nature must cease to exist. On the contrary, if Liebig's idea of the food of plants being exclusively mineral, can be realised, it follows, that, whatever destructive accidents the two kingdoms may be liable to in the course of time, they have, in their own economy, ample provision for an unlimited duration.*

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* Since the above communication was read, the translation of Mülder's Chemistry of Vegetable and Animal Physiology, from the original Dutch, by Dr Fromberg, has appeared. In this work Mülder predicts the extinction of the animal kingdom after a term of years, owing to the poisonous effect of carbonic acid accumulated faster in the air by an increase of animal respiration than it is decomposed by plants. He forgets here, that men and other animals cannot increase faster than the means of sustenance are supplied by the vegetable kingdom, and that, according to his own views, this vegetable sustenance cannot augment without a corresponding removal of carbonic acid from the atmosphere. The abundance of the crops raised for food must compensate for their small bulk, as compared with the pristine forests of the earth's surface; and,

Our next step is to examine what kinds of data exist for a calculation of the present amount of organic matter, or, for greater simplicity, of the present amount of carbon, in the organic compounds of the soil of the earth, to set against the annual demands supposed to be made upon it. The most devoted partisan of the theory of the organic nature of the food of plants must regard, I think, the following admission as even extravagantly favourable to his opinion. Notwithstanding the immense tracts of our planet covered by the ocean, inland seas, lakes, rivers, sandy deserts, rocks, rocky mountains, and the eternal snows of Alpine and the Polar regions, I assume one-fifth of its surface to be covered with soil to the depth of one foot; one-tenth, or ten per cent. of this soil to be organic matter, and three-fifths of this organic matter to be carbon. On these data, taken in round numbers, I find there would be nearly three billions and a half of tons of carbon in the organic compounds of the soil of such a portion of the earth's surface.

This limit the quantity of soil cannot possibly exceed; and it would probably bring us nearer the truth to make the estimate of its amount on such data as the tenth part of the earth's surface, six inches of depth and one-twentieth, or five per cent. of organic matter. If these last data be assumed, the first quantity, namely, three billions and a half of tons of carbon, will become reduced to one-eighth, or to something more than four hundred thousand millions of tons.

Between these two limits the truth, I think, must lie.

If the first estimate be adopted, the soil would bear an annual drain of 600 millions of tons of carbon for nearly six thousand years, or for a period equal to that which seems to have elapsed since man appeared upon the earth. On the second estimate, the soil, at the same rate of consumption, would be completely exhausted of carbon, and, therefore, of organic matter, at the end of 740 years.

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according to the probable data assumed in the paper, the conversion of the whole carbon of the organic matter of the soil, and of living plants and animals into carbonic acid, would not more than double the small proportion of that gas existing at present in the atmosphere.

But, it will be asked, does the annual expenditure of the carbon of organic compounds rise at present so high as 600 millions of tons?

If the daily waste of carbon by the human race, in the act of respiration alone, be estimated at no more than five ounces for each individual, the annual consumption will amount to one-twelfth part of the above quantity, or to 50 millions of tons.

Domesticated animals, horses, and other beasts of burden, dogs, oxen, sheep, hogs, and poultry, as coming to an early maturity, consume at least twice this quantity, or 100 millions of tons.

The rest of the animal creation cannot dispense with less than the sum of these two quantities, or 150 millions of tons.

And the other numerous sources of waste above mentioned, including combustion, cannot be over-rated at as much again, or 300 millions of tons—or, in all, 600 millions of tons. All the above estimates are designedly under-rated.*

No doubt the final extinction of the two living kingdoms of nature would be somewhat protracted beyond the period assigned under either of the above suppositions, because a gradual diminution in the sources of expenditure could not but at last commence, while under the diminution of plants and animals successive additions would be made to the soil. But it seems probable that an exact calculation would shew that all the carbon of living plants and living animals would not supply the present rate of expenditure much above 300 years; while, on the other hand, there is good reason to believe that the rate of expenditure is still rapidly increasing, and that it must hereafter greatly exceed its present limits before any decline is possible.

The exhaustion of the fertility of land by successive grain crops gives some countenance to the belief of organic matter in the soil being the chief food of plants; but this is susceptible of a different explanation, while other facts lead to the contrary inference; for instance, the manifest increase in quantity of organic matter in the soil of a field after some years of permanent pasture. Nor does the aspect of the earth's surface at present give any sensible indications of its having already lost half of the original store of material destined for the maintenance of plants and animals.

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* See Appendix.

But to enter at present on the changes of particular parts of the soil would lead me too much into matters of detail, while the general argument with which I am engaged is but half concluded.

Hitherto I have supposed the hypothesis to assume (what some physiologists still maintain) that there is no decomposition of the carbonic acid of the air by the green parts of vegetables, or, at least, that there is no compensation by the vegetable kingdom for the carbon of organic compounds destroyed by the animal kingdom, and other sources of waste in nature. But this is not the form in which the hypothesis is most generally maintained at present—the evidence of the appropriation of carbon by plants from the inorganic carbonic acid of the atmosphere is so conclusive, that the opposition to this belief may be regarded as already making its expiring effort. And here it should be remarked, that the acknowledgement of a great part of the constituent carbon of plants being drawn from an inorganic compound in the atmosphere, is a plain admission of an analogy which goes far to make it probable that all the food of plants is inorganic.

But does this limitation better the hypothesis of the food which the soil affords being organic matter. Carbon is not the only constituent of plants: wherever the vegetable tissue contains carbon, it contains hydrogen also, in fixed proportions, along with oxygen, and even nitrogen. Now, it cannot avail to assume that the exhaustion of the carbon of the soil is postponed by a large proportion of the carbon of plants being derived from inorganic matter in the atmosphere, while the remaining portion, along with their hydrogen, &c., is drawn from organic matter in the soil. For the fixed constitution of the vegetable tissues must be preserved as respects all their component elements. A plant cannot fix carbon in its substance without obtaining from some source the due relative proportion of hydrogen and its other elements. If this hydrogen be supposed to be obtained from the organic matter of the soil, all the advantage of the supply of carbon from the atmosphere is lost; for the organic matter of the soil, in supplying the due proportion of hydrogen, must set free as much carbon as would have sufficed for the growth of the plant, were none afforded by the atmosphere—unless, indeed, the organic compounds of the soil contained a less proportion of carbon, as compared with their hydrogen, than the tissues of plants; which is known to be contrary to the truth. Thus, were the organic matter of the soil the sole source of the hydrogen of plants, there would be a continual accumulation of carbon in the soil, unless it be supposed to be as constantly added to the atmosphere, by combining with the oxygen absorbed into its porous substance.

It is manifest, however, particularly on this last supposition, that the soil would be exhausted as rapidly as if no carbon were afforded to plants by the atmosphere.

On the contrary, the assumption adopted by Liebig—of water being at once the source of the constituent hydrogen and oxygen of plants—points to an inexhaustible supply of these two elements, such as can keep pace with the fixation of carbon from the air, however rapid that may be.

One difficulty presents itself, namely, that some vegetable compounds contain a considerably larger proportion of hydrogen, as compared to their oxygen, than water. And this fact seems to point to the conclusion, that there are other sources of the hydrogen of plants; and these may be inorganic, as ammonia and light carburetted hydrogen. This subject I must relinquish for the present; but I would remark, that, in connexion with the supposition of ammonia being a source of the hydrogen of the vegetable kingdom, the evolution of nitrogen from the leaves of plants has not yet obtained a sufficiently attentive examination.

Liebig assumes that the source of the oxygen of plants is the decomposition of water. And few difficulties present themselves on this head not already adverted to. The quantity of oxygen, however, absorbed by the soil in the preparation of the ground for seed, and during the growth of plants, is plainly greater than might be expected from the small proportion of carbon derived from the soil. This point, also, deserves farther examination.

The source of the nitrogen of plants is, according to Liebig, exclusively from ammonia accumulated in the soil. He refuses to believe that the nitrogen of the air enters into the constitution of plants, either directly, in its simple state, or indirectly, by passing first into ammonia. This is a topic of the very last importance, and is the principal novelty in Liebig's view of the nutrition of vegetable bodies.

The ammonia that serves for food to plants is, according to Liebig, originally of mineral origin; for example, from volcanic sources. This ammonia passes into the azotised parts of plants, especially into those destined to be the food of animals; and this is the source of the abundant nitrogen of the animal kingdom. The excretions of animals, and the decomposition of animal and vegetable substances, restore this ammonia to the soil, or, if it has escaped into the air, it is brought back by rains; in either case to pass through the same circuit.

This view of Liebig's will hardly stand the same kind of test to which the idea of organic matter being the sole food of plants was subjected above. For, if his opinion be correct, the amount of organic life on our globe must be limited by the quantity of ammonia existing at the surface; it never can pass the limit fixed by the quantity of ammonia.

If, then, there be any waste of ammonia, if there be any portion of the nitrogen of plants or animals (both equally by hypothesis derived from this source) which does not return to the state of ammonia, there must be a gradual extinction of the organic world, like what was before referred to in the case of carbon. The only alternative is, that the volcanic, or other similar sources of ammonia, shall be shewn to be in constant operation, so as to compensate for the whole waste here supposed.

But it is impossible that there should not be in nature a great annual waste of ammonia,—that is, a great annual decomposition of it into its mineral elements, or into that form under which, according to Liebig, its nitrogen cannot directly or indirectly avail for the nutrition of plants; nor does it clearly appear that the sources of its extrication from the bowels of the earth are in uninterrupted operation.

It has been well remarked by Professor Johnson, that the ammonia which rises into the air can hardly escape frequent resolution into its elements, since electric shocks decompose it with ease in the laboratory. In this way it would, according to Liebig, be irrecoverably lost to organic nature.

To this source of waste, I would add, that the ammonia which rises from the decomposition of animal substances at the earth's surface, must, by the law of the diffusion of gases, especially during the long absence of rains, extend itself upwards beyond the limits of aqueous vapour, and will, therefore, set at nought the power of rain to bring it back to the earth's surface. In short, unless the electricity of the higher atmosphere can decompose ammonia, it must go on, slowly accumulating above the point to which aqueous vapour reaches, descending only when the supply from the earth to the lower atmosphere is less copious; and if ammonia be decomposed in the higher atmosphere, we obtain one source of inflammable gas, namely, hydrogen, to feed luminous meteors in that region, the same electric power being capable of causing its union with oxygen into water.* It is to be remarked, however, that, if this decomposition went on for ages evolving nitrogen, there would be an increase in the proportion of atmospheric nitrogen, unless it were again converted into ammonia at the surface.

It would be easy to point out other sources of the waste of ammonia. For example, nitre is formed chiefly (according to Liebig exclusively, as I should infer) at the expense of the nitrogen of animal matter, and it does not appear that it returns again to the state of ammonia. In regard to one great source, at least, of the consumption of nitre, namely, the discharge of gunpowder, it is known that the nitrogen is evolved in the uncombined state; and is thus, under Liebig's view, irrecoverably lost as a means of sustenance to living bodies. Thus, gunpowder would shew itself under a doubly fatal character;—fatal in its immediate effect on life, and fatal, by tending to abridge the duration of the organic world!

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* Under the ordinary atmospheric pressure at the earth's surface, ammoniacal gas requires, for its liquefaction, a cold equal to − 61° of Fahrenheit. This is inferior to the calculated temperature of the planetary spaces, which, according to Fourier, cannot be below − 57° F. But, as the cold required for the liquefaction of a gas must increase with its rarefaction, there is no room for the belief that ammonia can separate from the higher atmosphere by passing into the liquid state, and thereby descending into the region of watery vapour.

But the number of cases now known in which ammonia forms from its elements, makes it impossible to join with Liebig in opinion, that ammonia is not produced from its elements in nature, independently of the presence of organic matter.

This is an interesting subject, but the time already occupied with these observations requires me to be brief.

It is long since the production of ammonia from its elements began to engage the attention of chemists. Priestley observed the formation of the volatile alkali under some circumstances; and it is not far from sixty years since Austin presented his paper to the Royal Society of London on the formation of volatile alkali. The evidence known to him was sufficient to warrant the conclusion, not merely that nitrogen and hydrogen unite to form ammonia when in the nascent state, but when one only of its elements, namely, hydrogen, is in that state. He refers to the remarkable experiment in which moistened iron filings, in a jar of nitrogen, confined over mercury, produce ammonia; and concludes that, "when iron rusts in contact with water in the open air, or in the earth, volatile alkali is formed." I am aware that Liebig ascribes the presence of ammonia in rust of iron to absorption from the atmosphere, and that an experiment made in his laboratory is thought to confirm this inference. But on such a point, common evidence is not to be listened to. When a current of moist air is passed over red-hot charcoal, carbonic acid and ammonia are produced. Mülder has recently added other experiments bearing on the same conclusion. Professor Johnson has put this subject in a clear light, and has succeeded, I think, in shewing the strongest reason for believing, that plants, especially in warm climates, derive part, at least, of their nitrogen from the nitric acid of nitrates existing in the soil.

As respects, then, the supply of nitrogen to plants, it is impossible to agree with Liebig farther than that ammonia is part of the food of plants. For a completely definite opinion the time has not yet arrived; but the interest given to this so long neglected subject by Liebig's affirmations, cannot but ensure its complete elucidation within a short period. This part of the subject I conclude with two propositions, which deserve the strictest examination.

1st, That ammonia is produced in the soil during the decomposition of parts of plants containing no nitrogen,—the nitrogen being, according to Berzelius, derived from the air; and, *2d,* in a decomposing mass of animal matter, that the nitrates first formed from the nitrogen of the animal matter, contrary to the common belief of chemists, induce, catalytically, the production of nitrates from the nitrogen of the air.

The last axiom drawn from Liebig's work, on which I proposed to comment, is, that the saline matters contained in plants are drawn exclusively from the soil, and are in no respect the product of vegetation. On this subject I must be more brief than I intended.

The ashes of plants, though not absolutely constant, are nevertheless in so far constant, as to shew that a certain saline constitution belongs, in its most normal and healthy state, to every species. Two difficulties present themselves in the investigation of this subject, namely, the substitution, by a kind of isomorphism, of one substance for another under peculiar circumstances; and the presence, on most occasions, of saline matters which are not essential but accidental. The general principle, as respects the saline constitution of plants taught by Liebig, is sufficiently made out, but the subject has been as yet too little studied in its details. The subject is, indeed, clear enough to a certain extent; but, until the whole of the respective offices of the inorganic and organic portions of the soil be made apparent, some doubts must hang over our conclusions.

Forms of potass and phosphates of a few bases, the most prevalent kinds of saline matter in the vegetable kingdom, exist in small proportion, diffused through the rocks of the crust of the earth. These can get into the soil only by the slow crumbling down of the rocky fragments which contain them. A quick succession of crops, requiring a large proportion of such saline constituents, will so far exhaust a soil of the parts already sufficiently comminuted to afford them; and thus the next crop will be inferior to the former. In process of time, the comminution proceeds; and then the previous fertility, in as far as it is dependent on this cause, returns, or it is restored at once by the same saline constituents being contained in the manure applied.

One thing, at least, is already certain, that the phosphates, which exist so abundantly in the animal kingdom, have no other source but the rocks of the crust of the earth. By the crumbling of these rocks they pass into the soil, from the soil into plants, and from plants, in the composition of vegetable food, into animals, from the excretions of which they pass again into the soil. The general admission of this last proposition is of very recent date, and has cost a great struggle. The contrary was taught by Schrader and Branconnot at the beginning of this century, and their views seem to have taken possession of the minds of naturalists, notwithstanding the opposition of the more philosophic De Saussure.

It is forty years since De Saussure exclaimed, "analysis demonstrates, that all the prevailing substances in the ashes of plants are contained in the soil; and that its soluble part, which alone penetrates into the vegetable economy, contains these substances in greater proportion than the insoluble part." Again, he says, "the explanations which I can give on this point are sometimes far from being perfectly satisfactory. These often require a knowledge which I have not attained—that of the vegetable organism. But they are less absurd than those which ascribe to plants a creative power as respects their elements."*

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* Recherches Chimiques sur la Végétation par Théod. De Saussure. A Paris, 1804, p. 284.

But I must draw this long paper to a conclusion. The spirit in which De Saussure so long since studied the vegetable economy, appears to have become dormant among botanists for a good many years. They had too little faith in the conclusions of modern chemistry to trust to it as an instrument of research. Nor was it surprising, at the commencement of this century, when chemistry was hardly beyond its infancy.

Not a few sciences have suffered severely from the rash transfer to them of principles and modes of investigation, of established success in other kinds of knowledge; but no science which has to do with matter is entitled to reject the conclusions of chemistry, as to the transmutations of which matter is susceptible. Modern chemistry, in so far as facts are concerned, can undergo no considerable change beyond the attainment of greater exactness. And this is true, even though the whole face of the science and its entire nomenclature should completely alter, as, in the course of time, is very likely to happen. But such an alteration is not a denial of its present facts, or a sinking of its past progress, but merely a change of the aspect under which its conclusions are regarded. Hence, whatever knowledge physiology borrows from chemistry, is not lost by the changes to which that science is subject; but must remain available in the study of the vegetable economy, though in an altered form.

Chemistry, in short, must always be the very groundwork of vegetable physiology. It must teach the number, the properties, the relations of the elements, which the vital force combines and operates on. And had this truth been more clearly seen, and more firmly held to, at an earlier period, it would not have been left for Liebig at this late day to surprise the world with the announcement of the great bonds of union which so strictly unite the operations of the vegetable economy with those of mineral and of animated nature. For Liebig has not taught much, the rudiments of which are not to be found in De Saussure's work. De Saussure taught in 1804 that plants fix carbon both from the carbonic acid of the soil and of the atmosphere; that they fix oxygen and hydrogen from water; that they derive their saline matter from the soil. He knew that ammonia is contained in some decomposing vegetable substances; but he does not appear to have arrived at Liebig's conclusion, that it is an essential part of the food of plants; and without affirming what Liebig so pointedly denies, namely, that the extractive matters of the soil are part of the food of plants, he contents himself with saying that these "contribute in a certain proportion to the fertility of the soil;" while he adds, in the same sentence, that "the ashes of these extractive matters contain the same principles as the ashes of plants."* Moreover, De Saussure notices, in particular, that vegetable mould contains more ammonia than the wood from which it forms; and this difference he ascribes to the effect produced on the soil by the numerous insects frequenting it.

It may be seen, then, that the spirit of the view adopted by Liebig is not of recent date. That plants convert mineral substances into their own substance is a proposition almost coeval with our knowledge of the ultimate composition of air, water, and soil. And all that is essential of this proposition remains unchallenged, even if the progress of inquiry shall graft the views of Mülder on those of Liebig, namely, that certain azotised substances formed in the soil, which have not yet lost their organic character, are indispensable. For if such compounds do aid in the nutrition of plants, it manifestly cannot be otherwise, than as yeasts contribute to fermentation. The substance of vegetables is from mineral nature. Plants metamorphose parts of the mineral covering of our planet into organic substance. Animals dissolve the spell bound on it by vegetable life, and re-convert this organic matter into its original mineral condition. Thus, from air, water, and a little soil, all organic bodies are made.

> Sic modo quæ fuerat rudis et sine imagine tellus
> Induit ignotas hominum conversa figuras.

And thus modern science realizes the happy conjecture of the ancients as to the number of the elements. The four elements of the ancients are the elements of organic nature

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* Recherches Chemiques sur la Végétation, par Théod. De Saussure, p. 185.

—Air, Water, Earth, and Fire, are in truth the elements of the organic world; for their fire represents that warmth, the absence of which extinguishes all organic life.

A brief notice of the mode in which the numerical results made use of have been brought out may be satisfactory, and will shew that no exaggeration has been practised to the prejudice of the opinion that the food of plants is organic substance.

The area of the earth's surface is roundly estimated in square miles, by multiplying the circumference into the diameter.

24,000 × 8000 = 192,000,000, area of the earth in square miles.

$$\frac{192,000,000}{5} = 38,400,000, \left\{\begin{array}{l}\text{one-fifth part of the earth's}\\ \text{surface in square miles.}\end{array}\right.$$

The number of square feet in a square mile is 27,878,400; whence 38,400,000 × 27,878,400 = 1,060,520,560,000,000, the number of cubic feet of soil, a foot deep, in the surface of one-fifth part of the area of the earth.

A cubic foot of water weighs 1000 ounces avoirdupois; call soil twice the density of water, which is near its density; then a cubic foot of soil weighs 2000 ounces, or 125 pounds:

125 × 1,060,520,560,000,000 = 132,564,071,000,000,000,

which number represents the quantity of soil in avoirdupois pounds contained in one-fifth part of the earth's surface.

The same reduced to tons is 59,180,388,839,285.

Take ten per cent. of this quantity as organic matter,

5,918,038,883,928.

Take three-fifths of the organic matter as carbon,

3,550,823,320,352; or there is something more than three billions and a half of carbon in the soil of one-fifth part of the earth's surface.

If a thousand millions of men consume daily five ounces of carbon each in respiration, they consume in a year 50,922,420 tons of carbon. A horse, according to Boussingault, throws off, in carbonic acid, 6·07 pounds of carbon, or nearly a ton in a year (·988 ton).

The horses of Great Britain, on a moderate calculation, are estimated at a million and a half;* and the inhabitants of Great Britain are less than a fiftieth part of the human race: say, then, there are fifty times as many horses in the world as in Great Britain, and horses alone will be found to consume every year nearly 75,000,000 of tons of the carbon of organic matter.

An ox or cow converts nearly four and a half pounds of carbon daily into carbonic acid. There are about three millions and a quarter of cattle in Great Britain;† or the cattle of Great Britain must consume more than three millions and a quarter of tons of carbon annually in respiration; and if the black cattle all over the earth be in the like proportion to the number of inhabitants, these alone will consume more than 150 millions of tons of the carbon of organic matter in a year (162,500,000).

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* Macculloch's Statistical Account of the British Empire, vol. i. page 284.

† Ib. page 490.

The number of sheep in Great Britain is estimated at about 40 millions (39,648,000).* Take the average weight of each at no more than fifty pounds, the weight of the whole comes to nearly a million of tons; or, at all events, since in warm-blooded animals the quantity of carbon thrown off by respiration in a year considerably exceeds the weight of the animals, there must be at least a million of tons of the carbon of organic matter converted yearly into carbonic acid by the sheep of Great Britain.

This should give, for the annual consumption by sheep, over the whole earth, fifty millions of tons of carbon.

Hogs, rabbits, poultry, &c., in Great Britain can hardly amount to less than half the weight of the sheep, or to half a million of tons. It may be reckoned, then, that such animals over the whole earth consume annually not less than twenty-five millions of tons of carbon—thus:

Carbon consumed yearly by men, .	50,000,000 tons.
... ... by horses, :	75,000,000
... ... by cattle, .	150,000,000
... ... by sheep, .	50,000,000
... ... by hogs, poultry, &c.	25,000,000
Combustion of wood, being at half the rate at which coal is consumed for domestic purposes in Great Britain, : .	425,000,000
	775,000,000 tons.

By a reference to the paper it will be seen that many sources of the consumption of the carbon of organic compounds are not taken into account in the above computation; and, in particular, that the consumption by animals in the wild state is not added. It seems not unlikely, then, that instead of 600 millions of tons, at which the annual waste was stated in the text, double that quantity would come nearer the truth.

Researches in Elucidation of the Distribution of Heat over the Globe, and especially of the Climatic Features peculiar to the Region of the United States.

By SAMUEL FORRY, M.D., Author of "The Climate of the United States, and its Endemic Influences," Editor of "The New York Journal of Medicine and the Collateral Sciences," &c.

Climatology, notwithstanding of the highest interest to man in every conceivable relation of his present existence,

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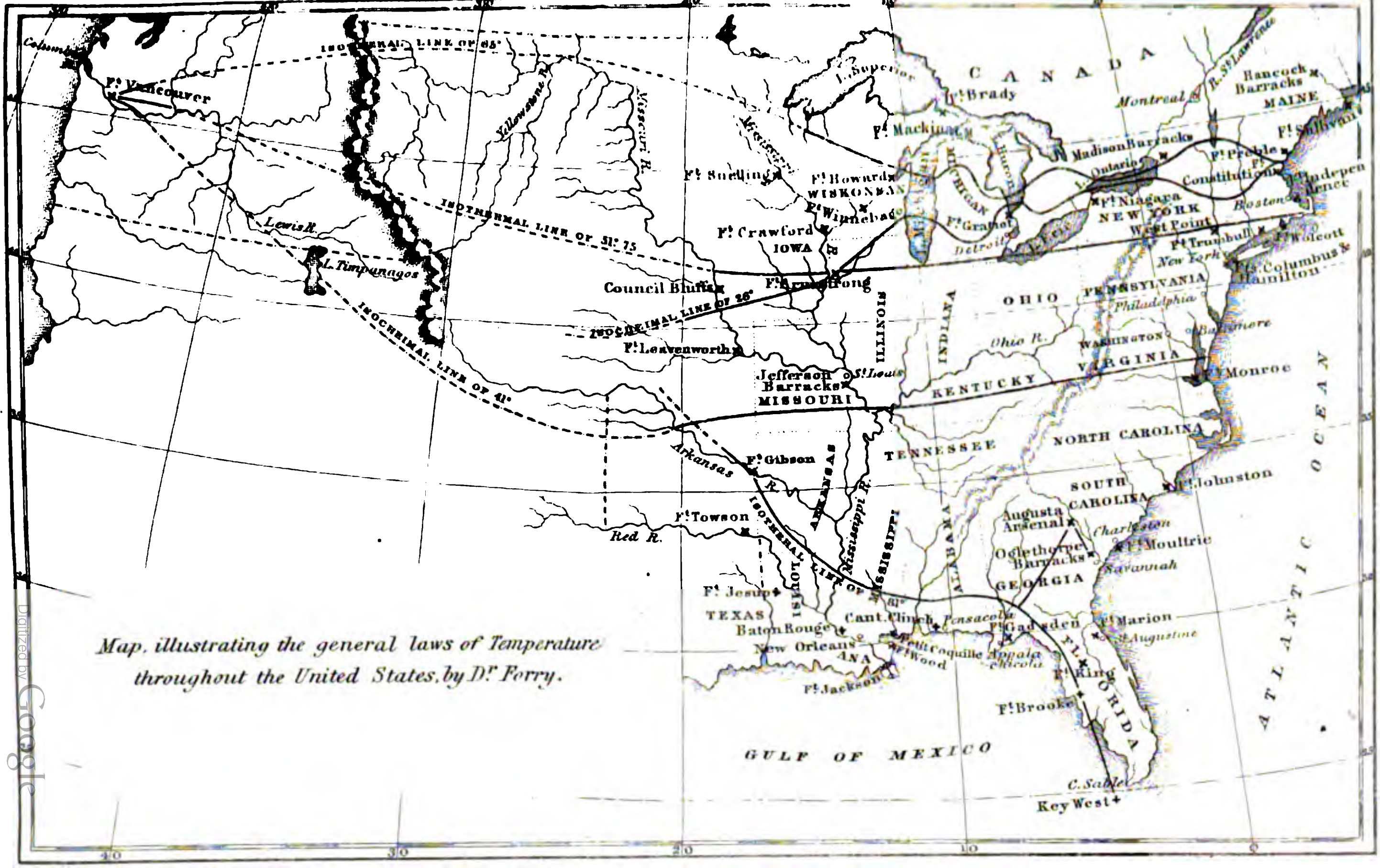
* Macculloch's Stat. Account of the British Empire, vol. i., p. 496.



Map, illustrating the general laws of Temperature throughout the United States, by Dr. Forry.

has, in the wonderful advancement of human knowledge during the current half century, especially as regards the natural sciences, by no means kept pace with the progress of its kindred branches. With us, the barren work of M. Volney on the climate of the United States, written forty-five years ago, when this French *savant* made a flying visit through our country, is still quoted by every writer on this topic. To Baron Humboldt is due the distinguished credit of having first generalized the various meteorological data, which had been accumulated in different parts of the globe; but so little do philosophers seem to have profited by these deductions, that even one of the latest writers, Mr Charles Lyell, in his "Principles of Geology," when speaking of the mild climate of Europe, says—"But this region, constituting only one-seventh of the whole globe, proved eventually *to be the exception to the general rule.*" Now, it will be a leading object of this paper, contrary to the opinion here advanced, to demonstrate the harmony of the laws of climate throughout the globe.*

The merit of being first to establish, on an extensive scale, a system of meteorological observations, with a view to the elucidation of the climate of the United States, is due to the Medical Bureau of the army; and these registers date back regularly to the year 1819, when Dr Joseph Lovell was the Surgeon-General. The only instruments used at first were a thermometer and vane; and to these the observations were long confined, with general notices of the weather. At the present time, however, observations are taken on a more extended scale, comprising the barometer, the thermometer attached and the thermometer detached, the pluviometer, Daniell's hygrometer, the wet bulb, and observations upon the clouds, the clearness of the sky, and the force and direction of the winds.†

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* In presenting the present analysis of our various writings on the laws of temperature of the United States, we have not hesitated, as regards the dry details of mere facts, to adopt the language used on previous occasions.

† The Medical Bureau procured a number of Daniell's hygrometers from London—an instrument characterized by beauty, simplicity, and

These data were allowed to accumulate in the Medical Bureau for twenty years, before any comprehensive attempt was made to determine their relations to one another, and to deduce from them general laws; and it fell to our lot, under the direction of the present Surgeon-General, Thomas Lawson, Esq., to present a systematic arrangement of these isolated facts, embracing the climatology of a vast district, extending from the oldest settlements on the Atlantic shores to the farthest outposts of civilized occupation, even to the coasts of the Pacific. Thus were presented, under the sanction of the War Department, unlike all other treatises on the same subject, which are generally loosely written and made up of the most vague and general statements, deductions based upon precise instrumental observations.

As regards the phenomena of superficial terrestrial temperature, let it here suffice to refer to its dependence upon two classes of causes, viz. those resulting from celestial relation, and those produced by geographical position. The former, which may be called the *primary* constituents of climate, result from the globular figure of the earth, its diurnal motion upon its axis, and the obliquity of its motion in an elliptical orbit in regard to the plane of the equator. Now, if this class of causes solely controlled the phenomena of terrestrial temperature, climates might be classified with mathematical precision; but the effects produced by solar heat are so much modified by local causes, that the climatic features of any region can be determined only by observation. It is these last, the *secondary* constituents of climate, that we have chiefly to do with in the present inquiry; and among these geographical or local causes, the following may be regarded as the principal:—1. The action of the sun upon the surface of the earth. 2. The vicinity of great seas and their relative position. 3. The elevation of the place above

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portableness; but, however well it may be adapted to the humid climate of England, experience soon demonstrated its inapplicability to the arid atmosphere of the United States, with the exception, perhaps, of our southern borders; and hence has been imposed upon the Department the necessity of using the wet bulb thermometer in determining the hygrometric condition of the air.

the level of the sea. 4. The prevalent winds. 5. The form of lands, their mass, their prolongation toward the poles, their temperature and reflection in summer, and the quantity of snow which covers them in winter. 6. The position of mountains relatively to the cardinal points, whether favouring the play of descending currents, or affording shelter against particular winds. 7. The colour, chemical nature, and radiating power of soil, and the evaporation from its surface. 8. The degree of cultivation, and the density of population. 9. Fields of ice, which form, as it were, circumpolar continents, or drift into low latitudes. It is these causes that determine the deviations of the *isothermal*, *isocheimal*, and *isotheral* lines from the same parallels of latitude.

In the investigation of the laws of climate, a range of subjects so multifarious as to comprise almost every branch of natural philosophy, is embraced; but its true province is properly restricted to a general view of these subjects, which, if based on legitimate deductions of observed phenomena, should enable us to reduce the infinite variety of appearances presented to us in nature, to a few general principles. It is by means of this generalization that the subject will be elevated to the dignity of a science. Climate comprises not only the temperature of the atmosphere, but all those modifications of it which produce a sensible effect on the physical and moral state of man, as well as on all other organic structures, such as its serenity, humidity, changes of electric tension, variations of barometric pressure, its tranquillity as respects both horizontal and vertical currents, and the admixture of terrestrial emanations dissolved in its moisture. Climate, in a word, constitutes the aggregate of all the external physical circumstances appertaining to each locality in its relation to organic nature.

In the present inquiry, however, our labours will be restricted almost wholly to the mere physical laws of climate. As the climate of every region has an inseparable relation with its physical characters, it follows that, in the investigation of its climatic features, a geographical description becomes an essential preliminary; but, in the present instance, the country to be described is of so vast an extent as to preclude any thing beyond the most general outlines. It was well remarked by Malte-Brun, that "the best observations upon climate often lose half their value, from the want of an exact description of the surface of the country." Presuming that our readers are sufficiently well acquainted, for the present purpose, with the physical features of the vast region stretching from the Atlantic to the Pacific, and from the Gulf of Mexico to the inland seas on our northern frontiers, the descriptions will be limited to such parts alone as are essential.

One of the most striking characteristics of the physical geography of the United States, and which, it will be seen, induces the most remarkable modifications of climate, is the existence of those great inland basins of water which lie on our northern frontier. Of so vast an extent are these ocean-lakes, that one of them (Lake Superior) has a circuit, following the sinuosities of the coast, of 1750 miles. The basin of the St Lawrence is truly a region of "broad rivers and streams," containing, it is estimated, an area of 400,000 square miles, of which 94,000 are covered with water. From the western extremity of Lake Superior to the Gulf of St Lawrence, the distance is about 1900 miles. These ocean-lakes have been estimated to contain 11,300 cubic miles of water,—a quantity supposed to exceed more than half of all the fresh water on the face of the globe. The deepest chasms on the surface of either continent are presented perhaps by the depression of these lakes; for though elevated near 600 feet above, the bottom of some is as far beneath, the level of the ocean. Lakes Huron and Michigan, which have the deepest chasms, have been sounded to the amazing depth of 1800 feet without discovering bottom.

The following table, which gives the mean length, breadth, depth, area, and elevation of these several collections of water, is taken from a recent report made by Douglas Houghton, Esq., state geologist of Michigan.

Collections of water.	Mean length in miles.	Mean breadth in miles.	Mean depth in feet.	Elevation above level of the sea, in feet.	Area in square miles.
Lake Superior,	400	80	900	596	32,000
Green Bay,	100	20	500	578	2,000
Lake Michigan,	320	70	1000	578	22,400
Lake Huron,	240	80	1000	578	20,400
Lake St Clair,	20	18	20	570	360
Lake Erie,	240	40	84	565	9,600
Lake Ontario,	180	35	500	232	6,800
River St Lawrence,	...	...	20	...	940
				Aggregate,	94,000

With these preliminary remarks, we are prepared to enter into a detail of the numerical results furnished in the several systems of climate pertaining to the United States. The military posts furnishing the thermometrical data will consequently be classified as under—

General divisions of the United States.	Systems of climate.
1. Northern.	1st Class.—Posts on the Coast of New England, extending as far south as the harbour of New York.
	2d ... Posts on the northern chain of lakes.
	3d ... Posts remote from the ocean and inland seas.
2. Middle.	1st Class.—Atlantic coast, from Delaware Bay to Savannah.
	2d ... Interior stations.
3. Southern.	1st Class.—Posts on the Lower Mississippi.
	2d ... Posts in the Peninsula of East Florida.

These general divisions, intended as well to facilitate description as to express the operation of general laws, may be regarded, in a great measure, as arbitrary. The *northern* embraces a region characterized by the predominance of a low temperature; in the *southern*, a high temperature prevails; while the *middle* exhibits phenomena vibrating to both extremes. Each of these general divisions, as exhibited in the table above, is subdivided into well marked classes or systems.

As the present paper will not allow the admission of extensive tables of figures, the writer is obliged to confine himself to mere results, referring the reader who may be more curious on this subject to the author's work, "The Climate of the United States, and its Endemic Influences," which contains a series of extensive tabular abstracts of instrumental observations. These results are obtained from observations made at the various military posts between 24° 33′ and 46° 39′ of north latitude, embracing a space of 22° 6′, and an extent of longitude stretching from the Atlantic to the Pacific. The thermometrical observations were made thrice daily; and as the mean of each month is calculated from 90, and of each year from 1095 observations, the numerical ratios, it is believed, will give an approximation to the truth as near as can be realized by ordinary observation, and a mean sufficiently correct for every contemplated purpose. The results, at the majority of the posts, are based on from five to ten thousand observations.

1. *The Northern Division.*—As this region presents the greatest diversity of physical character, so it exhibits the most marked variety of climate. East of the chain of great lakes there are several mountain ranges, which, with the exception of a few summits, seldom attain a height of more than 2500 feet above the level of the sea; and of this elevation, perhaps one-half is formed by the table-lands upon which the ridges rest. Above the falls of Niagara, the region of the lakes is elevated 600 to 700 feet above the ocean, but there are scarcely any ridges that deserve the name of mountains. This immense tract is, with the exception of the eastern states, nearly altogether in a state of nature, being still covered with its dense primeval forests. But the most striking characteristic in the physical geography of this division, is that produced by its vast lakes or inland seas. We here behold a chain of lakes presenting a superficial area of 94,000 square miles, with a mean depth of 1000 feet in the principal lakes, the details of which have just been given.

In accordance with the diversity in the physical geography, we find that, on the sea-coast of New England, the influence of the ocean modifies the range of the thermometer; thus equalizing the temperature of the seasons. Advancing into the interior, the extreme range of the temperature increases, and the seasons are violently contrasted. Having come within the influence of the great lakes, a climate like that of the sea-board is found; and proceeding into the region beyond the modifying agency of these inland seas, an excessive climate is again exhibited. And if we continue our route as far as the Pacific Ocean, a climate even more mild and equable than similar parallels in Western Europe, as will be satisfactorily demonstrated, will be presented. The variations of the *isotheral* and *isocheimal* curves—the lines of equal summer and of equal winter temperature, as illustrated in Plate I., thus afford a happy illustration of the equalizing tendency of large bodies of water. Hence the former division of the surface of the earth into five zones, as regards its temperature, has been superseded in scientific inquiries by a more precise arrangement. Places having the same mean annual temperature are connected by isothermal lines, and the spaces between them are called isothermal zones.

It is thus seen that, notwithstanding the mean annual temperature presents little variation on the same parallels, four striking inflections of the isotheral and isocheimal lines are exhibited in rapid succession, constituting two systems of climate, viz. that of the Atlantic Ocean and the great lakes, which pertains, comparatively speaking, to the class of *mild* or *uniform*, and that of the intervening tract and the region beyond the lakes, characterized as climates emphatically *excessive* or *rigorous*. The difference of climate, as the mean annual temperature is nearly the same, is, therefore, owing to the unequal distribution of heat among the seasons, as is well illustrated in the accompanying Plate I. At the posts on large bodies of water, the mean temperature of winter is higher, and that of summer lower, than in the opposite localities; but these results are more satisfactorily evidenced by comparing the difference between the mean temperature of winter and summer, and the warmest and coldest month in each system of climate. Thus Fort Brady, at the outlet of Lake Superior, shews a difference of only 42°·11 between the mean temperature of winter and summer, while Hancock Barracks, half a degree farther south, in the state of Maine, distant only one hundred and fifty miles from the sea-coast, exhibits a disparity of 46°·19; and comparing the warmest and coldest month, the difference of the former is 47°·22, and that of the latter 54°·70. Again, Forts Sullivan and Snelling, in opposite systems of climate, are very nearly in the same latitude, the former at Eastport, on the coast of Maine, and the latter at the junction of the St Peter's and Mississippi, Iowa. At Fort Sullivan, the difference of winter and summer is 39°·15, and that of the warmest and coldest month, 43°·87; while at Fort Snelling, these ratios are respectively 56°·60 and 61°·86. Fort Howard is also in the same latitude, but as it is situated at the extreme point of one of the smaller lakes (Green Bay, Wiskonsan), the temperature is partially modified, these averages being 50°·05 and 54°·11. Next come four posts, all of which are nearly on the same parallel, three being of the class of *uniform* climates, and one of that of *excessive*. Of the former, two, Forts Preble and Constitution, are on the ocean, and the other, Fort Niagara, is on Lake Ontario. At these posts, in the order just named, the difference between the mean temperature of winter and summer is respectively 41°·03, 36°·33, and 41°·73; while, on the other hand, at the *excessive* post, Fort Crawford, Wiskonsan—a point a few minutes farther south than the three former—the difference is 50°·89. The results at Salem, Massachusetts, based on thirty three years' observation by Dr Holyoke, though not directly under the influence of the ocean, confirms the same law, the differences between the mean temperature of winter snd summer being only 41°·66. At all these points, the contrast in the difference of the mean temperature of the warmest and the coldest month, is equally striking. The next points of comparison, as lying on the same parallel, are Forts Wolcott and Trumbull on the Atlantic, and Council Bluffs, Fort Armstrong, and West Point, in the opposite localities. The difference between the mean temperature of summer and winter at Fort Wolcott, Newport, Rhode Island, is 36°·55, and at Fort Trumbull, New London, Connecticut, it is 32°·56; while at Council Bluffs, near the junction of the Platte and Missouri, it is 51°·35—at Fort Armstrong, Illinois, 49°·05—and at West Point, N. Y., 40°·75. Between the two posts on the ocean and the two far in the interior, the difference between the mean temperature of summer and winter presents a disparity of from 15° to 17°; and as respects Fort Trumbull and West Point, which are precisely on the same latitude, the difference between these two opposite seasons, notwithstanding the latter is not more than fifty miles from the ocean, is 8°·19 less at the former post. As regards the difference between the mean temperature of the warmest and coldest months, these laws find confirmation in every instance. So remarkable is the influence of large bodies of water in modifying the range of the thermometer, that although Fort Brady, at the Sault St Marie, Michigan, is nearly 7° north of Fort Mifflin, near Philadelphia, and notwithstanding the mean annual temperature is more than 14° less, yet the contrast, in the seasons of winter and summer, is not so great at the former as at the latter. Fort Columbus, in the harbour of New York, offers, in some respects, an exception to the laws just developed; the range of the thermometer being greater than at some points farther north. As these results, which are based on nine years' observations, made on an island free from any agency which large towns may exercise, are doubtless correct, some causes of a local nature must exist to produce this effect. It is more than probable that this locality, in consequence of the configuration of the coast, does not lie in the direction of the most prevalent ocean-winds, and that hence its temperature is but partially modified.

The climate of Fort Snelling, which is the most excessive among all the military posts in the United States, resembles that of Moscow in Russia, as regards the extremes of the seasons, notwithstanding the latter is 11° farther north; but at Moscow the mean temperature both of winter and summer is lower—that of winter being as 10°·78 to 15°·95, and that of summer as 67°·10 to 72°·75. At Edinburgh, Scotland, in the same latitude as Moscow, the difference between the mean temperature of winter and summer is, on the other hand, not one-third as great, being only 17°·90; and even at North Cape, on the island of Maggeroe, in latitude 71°, which is the most northern point of Europe, this difference between the two seasons, so great is the modifying influence of the ocean, is no more than 19°·62, while at Uleo, in the interior of Lapland, the difference between the mean temperature of summer and winter is 45°·90.

In these comparisons of the Northern division, no particular reference has yet been made to Fort Vancouver, in Oregon Territory. This region bears the same climatic relation to our coast and to that of Eastern Asia, as the western coast of Europe does. The mean annual temperature is about 10° higher than that of the posts on the same parallel on our own coast. So mild and uniform are the seasons at Fort Vancouver, that the difference between the mean temperature of winter and summer is only 23°·67, a mean which is less than that of Italy or southern France, and only about two-fifths of that of Fort Snelling, Iowa, notwithstanding the latter is nearly 1° farther south. This contrast is well exhibited in Plate I.; for while the mean temperature of spring, summer and autumn, at Fort Vancouver, is about the same as at Fort Wolcott, Rhode Island, the winter line comes nearly as far south as Fort Gibson, Arkansas. But even this comparison, at first view, falls short of the reality; for, as regards the difference between the mean temperature of winter and summer, the contrast is less at Fort Vancouver than at Cantonment Clinch near Pensacola, or Petite Coquille near New Orleans. These results, however extraordinary they may appear, find, as will be seen, an explanation in physical causes.

The next point demanding attention is the difference between the mean temperature of winter and spring, which is much the greater in the *excessive* or rigorous climates. Taking places in the same latitude and in opposite systems of climate, it is found at Fort Brady to be 18°·42, while at Hancock Barracks it is 24°·49; at Fort Sullivan it is 17°·16, while at Forts Snelling and Howard, it is respectively 30°·8 and 24°·10, the latter being partially modified by Green Bay; at Forts Preble, Niagara, and Constitution, and the city of Salem, the ratios are 18°·42, 16°·77, 16°·83, and 17°·89, and at Fort Crawford, on the other hand, it is 25°·83; and, lastly, at Forts Wolcott and Trumbull, it is 14°·71 and 11°·67; while at Council Bluffs, Fort Armstrong, and West Point, it is respectively 27°·47, 23°·99 and 18°·82. Fort Columbus, as in the preceding comparisons, stands as an exception, its ratio, notwithstanding it is lower than any one in the opposite class, being the highest in its own, with the exception of two posts. The peculiarity in the increase of the temperature of spring, as manifested in the vegetable kingdom, constitutes a feature which strongly characterizes excessive climates; for, as Baron Humboldt remarks, "a summer of uniform heat excites less the force of vegetation, than a great heat preceded by a cold season." Accordingly, we find that in these excessive climates (unlike the uniform ones on the ocean and lakes, in which the air is moist, and the changes of the seasons slow and uncertain), summer suceeeds winter so rapidly, that there is scarcely any spring, and vernal vegetation is developed with remarkable suddenness. At Fort Vancouver, the difference between the mean temperature of winter and spring is only 6°·67, which is about one-third of the difference observed at the posts in our *modified* climates on the same parallel, and little more than one-fifth of the difference exhibited in the *excessive* climate at Fort Snelling.

Another feature which characterizes these two systems of climate remains to be considered, viz. the mean annual range of the thermometer. Comparing the posts on the same parallel, the following relations are found:—At Fort Brady, on the one hand, the range is 110°, and at Hancock Barracks, on the other, it is 118°; at Fort Sulivan it is 104°, while at Forts Snelling and Howard, it is 119° and 123°; at Forts Preble, Niagara and Constitution, it is respectively 99°, 92°, and 97°, while at Fort Crawford, on the same parallel, it is 120°; and lastly, at Forts Wolcott and Trumbull, it is 83° and 78°, while at Council Bluffs, Fort Armstrong, and West Point, it is 120°, 106°, and 91°. Fort Columbus, as before, presents an exception. In further elucidation of the law regulating the extremes of temperature, the four following posts, which are all nearly on the same parallel of 41° 30′, the first two being on the ocean, and the last two far in the interior, remote from large bodies of water, may be adduced as striking examples:

	Highest.	Lowest.	Mean annual range.
Fort Wolcott, Newport, R. I.,	85	2	83
Fort Trumbull, New London, Ct.,	87	9	78
Council Bluffs, near the confluence of Platte and Missouri,	104	—16	120
Fort Armstrong, Rock Island, Ill.,	96	—10	106

These results, it may be necessary to add, exhibit the *average* range of a series of years, The *extreme* range, for example, at Fort Brady, during a period of eleven years (from 1820 to 1830 inclusive), is 130°, the mercury sinking in 1826 as low as —37°, and rising in 1830 to 93° Fahr. At Fort Snelling in 1821, the mercury sunk to —32°, and in 1827 rose to 96°, being a range of 128°. At Fort Howard, in 1823, it rose to 100°, and sunk to —38°; being a range in the same year of 138°. At Fort Crawford we find the mercury in 1820 noted as high as 99°, and in 1821 as low as —36°, being a range of 135°; at Fort Armstrong, in 1821, as low as —28°, and in 1830 as high as 98°, being a range of 126°; and lastly, at Council Bluffs as low, in 1820, as —22°, and in 1822 as high as 108°, being an extreme range of 130°. At the last named post, the thermometer rose every year above 100°. When the Southern division of the United States comes under investigation, it will be seen that the mercury there seldom rises as high as in our northern regions.

Hence it follows that latitude alone constitutes a very uncertain index of the character of climate; for although two places may have the same mean annual temperature, and thus be on the same isothermal line, yet the distribution of heat among the seasons may be extraordinarily unequal. So much, indeed, may the phenomena of superficial terrestrial temperature, as depending on the position of the sun, be modified by local causes, that a classification of climates, or a system of medical geography, having for its basis mere latitude, is wholly inadmissible.

It is thus seen that the climatic features of the coast of New England and of the region of the great lakes, exhibit a striking resemblance, while those of the third class of the same division are very dissimilar. In the climate of the third class of posts, distinguished by great extremes of temperature, by seasons strongly contrasted, and a corresponding dryness of the atmosphere (unlike the first two classes, in which the air is moist and the changes of the seasons slow and uncertain), a constant and rapid succession is observed among the seasons. Summer, for example, succeeds winter so rapidly that there is scarcely any spring, the influence of which is surprisingly manifested in the vegetable kingdom. As the summers of the third class are remarkable for extremes of temperature, the mercury often rising in June, July, and August, to 100° Fahr. in the shade, so the winters are equally characterised by extreme severity. From November to May, cold weather prevails, the ground being often covered with snow to the depth of three or four feet, and the general range of the thermometer being from the freezing point to 30° below zero.

The lowest temperature, taking the mean of a month, occurred at Forts Howard and Snelling. At the former, the mean of the month of February 1829, at 7 o'clock A. M., is —3°.17, and the mean of December 1822, at Fort Snelling, is —3°.61. This, it is to be observed, is merely the average of the morning observations for the month. Although the extreme severity of the winters at the posts remote from large bodies of water, has been already fully illustrated; yet the following remarks made by Surgeon Beaumont, when stationed, in 1829, at Fort Crawford, Wiskonsan, which is in the latitude of Fort Wolcott, R. I., may be added in further elucidation: "The month of January was remarkably mild and pleasant, the ground dry and free from snow, and the Mississippi unusually low and unfrozen. February was extremely cold, the weather clear and dry, and the thermometer ranging during the month from the freezing point to 23° below zero. From the 1st to the 16th, the mercury stood every morning, with the exception of three (the 6th, 7th, and 8th), between —4° and —23°, and did not rise above 20° above zero during these days. On the 2d, 3d, 4th, 5th, 9th, 10th, 11th, 13th, 14th, and 15th, the mercury at sunrise stood respectively at 14°, 16°, 4°, 16°, 23°, 18°, 20°, 18°, 10°, 6°, and 4° below zero; and on the 9th and 14th, it continued under —8° during the 24 hours. During the month the prevailing winds were northerly and dry, and the proportion of fair and cloudy weather was—clear twenty-two days, cloudy three, variable one, and snowy two. The mean depth of snow was about six inches. The month of March has been unusually cold and dry, with one or two light falls of snow, which, with the previous coat, has just been dissolved by the warmth of the solar rays without any rain. The ice on the Mississippi, which broke yesterday [March 30th], is now moving off *en masse.*"

Scarcely does a winter elapse that the Hudson River is not frozen over even in the vicinity of the city of New York; while Philadelphia, and even Baltimore, lying on the same parallels which in Europe produce the olive and the orange, have their commerce often interrupted from the same cause. The Delaware, which is the latitude of Madrid and Naples: is generally frozen over five or six weeks each winter. Even the Potomac becomes so much obstructed by ice that all communication with the District of Columbia, by this means, is suspended for weeks. Further north, the mouth of the St Lawrence is shut up by ice during five months in the year; and Hudson's Bay, notwithstanding it is in the same latitude as the Baltic Sea, and of thrice the extent, is so much obstructed by ice, even in the summer months, as to be comparatively of little value as a navigable basin.

We find, however, even on our northern coast, a climate comparatively mild. As Nova Scotia is perfectly insular, with the exception of a neck of land eight miles wide, and is so much intersected by lakes and bays that nearly one-third of the surface is under water, the mercury seldom rises above 88° in summer, or sinks lower than 6° or 8° below zero in winter. In addition to this, some influence must be exercised by the Gulf Stream, which strikes upon this part of the coast, "in tides of from 60 to 70 feet, overflows the country to the distance of several miles, and converts the mouths of streams, fordable at low water, into extensive arms of the sea, where whole fleets may ride at anchor."

The meteorological phenomena of Canada, Nova Scotia, New Brunswick, and Newfoundland, according to the data furnished in the British Army statistics, are in perfect harmony with the laws of climate developed in the United States. The climate of Nova Scotia, from the causes just stated, exhibits a marked contrast to that of Lower Canada on the same parallels. In Newfoundland, the climate is similar to that of Nova Scotia; but the summers, in consequence of the melting of the icebergs on the coast, are less warm, of shorter duration, and subject to more sudden vicissitudes. In Canada, remote from the Lakes, the climate is of the most excessive character. At Quebec, when walking along the streets, the sleet and snow frequently freeze in striking against the face; and here too the alternations of temperature are so sudden, that the mercury has been known to fall 70° in the course of twelve hours. Cold weather sets in as early as November, from the end of which month till May the ground remains covered with snow, to the depth of three or four feet. When the winds blow with violence from the north-east, the cold becomes so excessively intense, that the mercury congealed in the thermometer serves no longer to indicate the reduction of temperature. Wine and even ardent spirits become congealed into a spongy mass of ice; and as the cold still augments, there follows congelation of the trees, which occasionally burst from this internal expansion, with tremendous noise. During winter, the general range is from the freezing point to 30° below zero. The seasons do not, as in more temperate regions, glide imperceptibly into each other. In June, July, and August, the heat, which often attains 95° Fahr., is frequently as oppressive as in the West Indies.

On our western coast, the extremely modified climate of the region of Oregon, on a parallel five degrees north of the city of New York, has been already illustrated. During a year's observations at Fort Vancouver, the lowest point is 17°, and the whole number of days below the freezing point, are only nine, all of which are noted in January. We are told by Mr Ball, of the State of New York, by whom these observations were made, that he commenced plowing in January of the year 1833. "The vegetables of the preceding season," he says, "were still standing in gardens untouched by the frost. New grass had sprung up sufficiently for excellent pasture. * * * Though the latitude is nearly that of Montreal, mowing and curing hay are unnecessary, for cattle graze on fresh-growing grass through the winter. * * * Winters on the Columbia River are remarkably mild, there being no snow, and the river being obstructed by ice but a few days during the first part of January. Grass remained in sufficient perfection to afford good food; and garden vegetables, such as turnips and carrots, were not destroyed, but no trees blossomed till March, except willow, alders," &c.

2. *Middle Division.*—This division comprises two general systems of climates, which bear, in some degree, the same meteorological relation to each other as the modified climate of the great lakes and the coast of New England does to that of the third class of the same division. The posts furnishing the meteorological data of the Middle Division are the following:—Fort Mifflin, near Philadelphia, Washington City, Jefferson Barracks, near St Louis, Fort Monroe or Old Point Comfort in Virginia, Fort Gibson in Arkansas, Fort Johnston on the coast of North Carolina, Augusta Arsenal, Georgia, Fort Moultrie, Charleston Harbour, and Fort Jesup, near Sabine River, Louisiana. The laws of climate developed in the preceding division, do not find so happy an illustration in this one; for as the physical causes act less prominently, the effects are less marked. These posts cannot be happily arranged into the two classes of uniform and excessive climes, as the majority of them are of a mixed character. Fort Mifflin and Washington City do not properly pertain to either class, being in a measure under the influence of the Atlantic, while the south-western stations experience the powerful agency of the Gulf of Mexico. As we proceed south, the seasons become, as a general rule, more uniform in proportion as the mean annual temperature increases. Although the thermometrical results given at Washington City fairly place it in the class of excessive climates, yet on following the same parallel westward, a still greater contrast in the seasons is exhibited. Thus the difference between the mean temperature of winter and summer at Jefferson Barracks, notwithstanding it is about half

a degree further south then Washington City, is 1°.80 greater; and on comparing Fort Gibson, Arkansas, with Fort Monroe on the coast of Virginia, though the latter is 1° 15′ north of the former, the difference at Fort Gibson, in the same respect, is 3°.69 greater. Fort Johnston, on the coast of North Carolina, which is 0°.32′ north of Augusta Arsenal, Georgia, also exhibits a less extreme in the opposite seasons. Fort Mifflin, near Philadelphia, shews a greater contrast in the opposite seasons (so all-powerful is the equalizing influence of large bodies of water), than any one of the following posts, all being from two to seven degrees farther north, viz. Brady, Sullivan, Preble, Niagara, West Point, Constitution, Wolcott, and Trumbull; and Washington City exhibits greater extremes than the three last named.

The general laws, in reference to the difference between the mean temperature of winter and spring, already revealed in the Northern Division, are here confirmed. Jefferson Barracks shews a greater inequality than Washington City, and Fort Gibson than Fort Monroe. Fort Jesup cannot be fairly compared, by way of contrast, with a position in the same latitude on the Atlantic, as the warm atmospheric currents from the Gulf of Mexico exercise there a very appreciable influence.

The laws developed, as respects the mean annual range of the thermometer, are also here corroborated. Washington City has a mean annual range of 84°, while that of Jefferson Barracks is 89°; the ratio of Fort Monroe, on the one hand, is 73°, and that of Fort Gibson, on the other, is 89°; and lastly, the range at Fort Johnston is 62°, while that of Augusta Arsenal is 73°.

It is thus seen that the climate of the region of the great lakes on our northern frontier is not more contrasted in the opposite seasons than that of Philadelphia—an inference long since deduced, from the fact that similar vegetable productions are found in each, while the same plants will not flourish in the interior of New York, Vermont, and New Hampshire. The region of Pennsylvania, as though it were the battle-ground on which Boreas and Auster struggle for mastery, experiences, indeed, the extremes of heat and cold. But proceeding south along the Atlantic plain, climate soon undergoes a striking modification, of which the Potomac River forms the line of demarcation. Here the domain of snow terminates. Beyond this point, the sledge is no more seen in the farmer's barn-yard. The table-lands of Kentucky and Tennessee, on the other hand, carry, several degrees farther south, a mild and temperate clime.

3. *The Southern Division*, which is characterised by the predominance of high temperature, remains to be considered. On approaching our southern coast, climate undergoes a most remarkable modification. The seasons glide imperceptibly into each other, exhibiting no great extremes. This is strikingly illustrated on comparing the difference between the mean temperature of summer and winter at Fort Snelling, Iowa, and at Key West, at the southern point of Florida, the former being 56°·60, and the latter only 11°·34. Compared with the other regions of the United States, the peninsula of Florida has a climate wholly peculiar. The lime, the orange, and the fig, find there a genial temperature; the course of vegetable life is unceasing; culinary vegetables are cultivated, and wild flowers spring up and flourish in the month of January; and so little is the temperature of the lakes and rivers diminished during the winter months, that one may almost at any time bathe in their waters. The climate is so exceedingly mild and uniform, that besides the vegetable productions of the southern States generally, many of a tropical character are produced. The palmetto or cabbage palm, the live-oak, the deciduous cypress, and some varieties of the pine, are common farther north; but the lignum-vitæ, mahogany, log-wood, mangroove, cocoa-nut, &c., are found only in the southern portion of the peninsula. Here also, in common with our southern borders, the fig, date, orange, lemon, citron, pomegranate, banana, olive, tamarind, papaw, guava, as well as cotton, rice, sugar-cane, indigo, tobacco, maize, &c., find a genial climate. In contemplating the scenery of East Florida in the month of January, the northern man is apt to forget that it is a winter landscape. To him all nature is changed; even the birds of the air—the pelican and the flamingo—indicate to him a climate entirely new. The writer being attached in January

1833, to a boat expedition, the double object of which was to operate against the Seminoles, and to explore the sources of the St John's, found, in the midst of winter, the high cane-grass which covers its banks, intertwined with a variety of blooming morning-glory, (Convolvulus.) The thermometer at mid-day in the shade, stood at 84° Fahr,, and in the sun rose to 100°; and at night we pitched no tents, but lay beneath the conopy of heaven, with a screen, perhaps, over the face, as a protection against the heavy dews. Notwithstanding the day attains such a high temperature, the mercury just before daylight often sinks to 45°, causing a very uncomfortable sensation of cold. Along the south-eastern coast, at Key Biscayno, for example, frost is never known, nor is it ever so cold as to require the use of fire. In this system of climate, the rigours of winter are unknown, and smiling verdure never ceases to reign.

The climate of Pensacola and of New Orleans, the former represented by Cantonment Clinch, and the latter by Petite Coquille, the two posts being respectively in the vicinity of these cities, is nearly as much modified (in consequence of the agency of the Gulf of Mexico, and in regard to New Orleans the additional influence of large lakes), as similar parallels in East Florida. The laws of temperature relative to East Florida have been perhaps more satisfactorily determined than in any other region of the United States. We have here the data of four posts fortunately situated, viz. Fort Marion at St Augustine, on the eastern coast,—Fort Brooke at the head of Tampa Bay,* about thirty miles from the Gulf of Mexico,—Fort King, intermediate to these two points,—and Key West, belonging to the Archipelago, about sixty miles southwest from Cape Sable. As Fort King is situated in the interior, and the other three posts are on the coast, we have an additional illustration, even in a climate characterised by very little distinction of the seasons, of the modifying agency of large bodies of water; for the mean temperature of winter at Fort King is lower, and that of summer higher, than at the other three posts. Although Key West, which is 4° 39′ south of Fort King, has a mean annual temperature 3°·43 higher, yet the mean summer temperature is 2°.81 lower—a law which is strikingly illustrated on the map of the United States, which shews that the isotheral line of Key West cuts Savannah, Augusta, and Fort Gibson. This equalizing influence of the ocean is still further exhibited in the annual range of the thermometer, the mean of the monthly ranges, and the average difference of the successive months.† During the summer months, the morning and evening observations at Fort King and Key West are nearly the same, the disparity being caused by the exalted temperature of the former at mid-day. As is usual in southern latitudes, there is a little variation presented at Key West in the mean temperature of the same month in different years. Within the period of six years (from 1830 to 1835 inclusive), the mercury at Key West was never known to rise higher than 90°, or sink lower than 44°.

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* The old Spanish appellation was Espiritu Santo, or Bay of the Holy host, the name Tampa being then restricted to an arm.

There is little difference between the thermometrical phenomena presented at Key West and the Havannah. In the West India Islands, the mean annual temperature near the sea is only about 80°. At Barbadoes, the mean temperature of the seasons is as follows: winter 76°, spring 79°, summer 81°, and autumn 80°. The temperature is remarkably uniform; for the mean annual range of the thermometer, even in the most excessive of the islands, is, according to the British army statistics, only 13°, and in some not more than 4°. Contrast this with Hancock Barracks, Maine, which gives an annual range of 118°, Fort Snelling, Iowa, 119°, and Fort Howard, Wiskonsan, 123°!

The peculiar character of the climate of East Florida, as distinguished from that of our more northern latitudes, consists less in the mean annual temperature than in the manner of its distribution among the seasons. At Fort Snelling, for example, the mean temperature of winter is 15°·95, and of summer 72°·75, whilst at Fort Brooke, Tampa Bay, the former is 64°·76, and the latter 81°·25, and at Key West 70°·05 and 81°·39. Thus, though the winter at Fort Snelling is 54°·10 colder than at Key West, yet the mean temperature of summer at the latter is only 8°·64 higher. In like manner, although the mean annual temperature of Petite Coquille, Louisiana, is 2° lower—that of Augusta Arsenal, Georgia, nearly 8°—and that of Fort Gibson, Arkansas, upward of 10° lower—than that of Fort Brooke; yet at all, the mean summer temperature is higher. Between Fort Snelling, on the one hand, and Fort Brooke and Key West on the other, the relative distribution of temperature stands thus: difference between the mean temperature of summer and winter at the former 56°·60, and at the two latter 16°·49 and 11°·34; difference between the mean temperature of the warmest and coldest month, 61°·86, compared with 18°·66 and 14°·66; difference between the mean temperature of winter and spring, 30°·83 to 8°·35 and 5°·99; and the mean difference of successive months, 10°·29 to 3°·09 and 2°·44.

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† All these various results are presented in a tabular form in the author's work on "The Climate of the United States, and its Endemic Influences."

The diverse climatic peculiarities of Fort Snelling and Key West are delineated in the accompanying engraving, Plate II. The contrast in the course of the mean annual temperature of these two posts, as traced through each month, is indeed striking, while the variation of temperature on each of these monthly lines is still more marked. Although the average minimum temperature of Fort Snelling in January is as low as 22° below zero, while that of Key West is 57° above; yet, strange to say, we find the mean maximum temperature of July at the former 5° higher than at the latter. The course of the seasons are equally marked in their contrasts; for, while the curves of Key West are confined within a few degrees, those of Fort Snelling are so opposite that the lines of spring and autumn traverse each other at right angles, and those of summer and winter are so remote that the one is truly hyperborean, and the other tropical.

This remarkable equality in the distribution of temperature among the seasons in Florida, compared with the other regions of the United States, constitutes its chief climatic peculiarity; and the comparison, if extended to the most favoured situations on the continent of Europe, and the various islands of the Mediterranean and Atlantic held in highest estimation for mildness and equability of climate, is no way disparaging. A comparison of the mean temperature, that of the warmest and coldest month, and that of successive months and seasons, results generally in favour of peninsular Florida. The mean difference of successive months stands thus: Pisa, 5°·75; Naples, 5°·08; Nice, 4°·74; Rome, 4°·39; Fort King, interior of Florida, 4°·28; Fort Marion, at St Augustine, 3°·68; Fort Brooke, on the western side of Florida, 3°·09; Penzance, England, 3°·05; Key West, near the southern point of Florida, 2°·44; and Madeira, 2°·41. The mean annual range thus: Fort King, 78°; Naples, 64°; Rome, 62°; Nice, 60°; Montpelier, 59°; Fort Brooke, 57°; St Augustine, 53°; Penzance, 49°; Key West, 37°; and Madeira, 23°.

The want of instrumental observations until recently, to indicate with precision the actual or comparative humidity of the atmosphere in Florida, is to be regretted. That the air is much more humid than in our more northern regions, is sufficiently cognizable to the senses. The deposition of dew, even in the winter, is generally very great. To guard against the oxidation of metals, as for instance surgical instruments, is a matter of extreme difficulty. During the summer, books become covered with mould, and keys rust in one's pocket. *Fungi* flourish luxuriantly. The writer has known a substance of this kind to spring up in one night, and so incorporate itself with the tissue of a woollen garment as to render separation impracticable. As the rains, however, generally fall at a particular season, the atmosphere in winter is comparatively dry and serene. The following abstract of the monthly fall of rain at Key West is the mean of five years' observations:—

January 1·82, February 1·34, March 1·98, April 1·09, May 6 34, June 2·39, July 2·84, August 3·30, September 4·35, October 3·33, November 1·49, December 1·13; Annual average 31·40.

During six months, from November to May, it will be observed that the proportion of rain is but 8·84 inches, being little above one-fourth of the annual quantity. Now, as in tropical climates a portion of the year is known as the rainy season, and as the same quantity of rain descends in a considerably shorter space of time than in the temperate zone, it follows that the proportion of fair days and clear skies is infinitely in favour of the former. This is strikingly evidenced in a comparison of Fort King, in the interior of East Florida, and of our northern lakes already adverted to; the annual number of fair days at the former being 309, and at the latter only 117. On the coast of Florida, however, the average is not more than 250 days.

Thus it is demonstrated that invalids requiring a mild winter residence, have gone to foreign lands in search of what might have been found at home, viz. *an evergreen land, in which wildflowers never cease to unfold their petals.* But to treat of the advantage of peninsular Florida as a *winter* residence for pulmonic and other invalids from more northern latitudes, would be incompatible with our present object.

Having completed the details relative to each division of the United States, we may now take a glance at the general laws of climate, as illustrative of their harmony throughout the globe. It is an important general law in reference to both continents, that a striking analogy exists, on the one hand, in the climatic features of the western coasts, and, on the other hand, in those of the eastern shores. Thus in tracing the same isothermal line around the northern hemisphere beyond the tropic, it presents on the east side of both continents *concave*, and on the west side *convex*, summits. Following the mean annual temperature of 55°·40 Fahr. around the whole globe, we find it passes on the

E. coast of old world, N. Lat. 39° 54′, E. Lon. 116° 27′, near Pekin.
E. coast of new world, N. Lat. 39° 56′, W. Lon. 76° 16′, Philadelphia.
W. coast of old world, N. Lat. 45° 46′, W. Lon. 0° 37′, near Bordeaux.
W. coast of new world, N. Lat. 44° 40′, W. Lon. 104° 0′, Cape Foulweather, south of the mouth of Columbia.

On comparing the two systems, the concave and convex summits of the same isothermal line, "we find," says Humboldt, "at New York the summer of Rome and the winter of Copenhagen; and at Quebec the summer of Paris and the winter of Petersburgh. In China, at Pekin, for example, where the mean temperature of the year is that of the coast of Brittany, the scorching heats of summer are greater than at Cairo, and the winters are as rigorous as at Upsal."

The difference of climate between western Europe and eastern North America, was long since determined by Humboldt, in his paper on *Isothermal Lines, and the Distribution of Heat over the Globe;* but these various relations, owing of course to the paucity of his data, are not characterised by much precision.

The isothermal line of 41°, which, according to this philosopher, passes through the Bay of St George, in Newfoundland, in the latitude 48°, if correctly ascertained, sinks as it penetrates towards the interior of the continent; for at Hancock Barracks, Maine, in latitude 46° 10′, at a distance of one hundred and fifty miles from the Atlantic, the mean annual temperature is 41°.21, and at Fort Brady, at the outlet of Lake Superior, in latitude 46° 39′, it is 41°.39; and proceeding to the western coast of America, we find that at Fort Vancouver, Oregon Territory, in latitude 45° 37′, the mean temperature, like similar parallels in western Europe, is as high as 51°.75.

As the region of the United States, however, exhibits very diverse systems of climate, even on the same parallels, such comparative tables, as, for instance, the difference of the seasons from the equator to the polar circle, can present only the most general laws. For example, it shews that on the isothermal line of 41°, the mean temperature of winter is 14°, and that of summer 66°.20—a result obtained from observations made in lat. 48°, on the Bay of St George, Newfoundland. Now, according to the "Army Meteorological Register," this isothermal line is again found in the comparatively equalized climate of Fort Brady, at the outlet of Lake Superior, in lat. 46° 39′, where the mean temperature of winter is as high as 21°.07, while that of summer is only 63°.18. Again, the table shews that on the isothermal line of 50°, the mean temperature of winter is 30°.20, and that of summer 71°.50; but this too gives only a partial view, as at Fort Wolcott, Rhode Island, the former is 32°51, and the latter 69°.06, and at Council Bluffs, near the junction of the

Platte and Missouri, 24°.47 and 75°.82; thus shewing that the disparity in the mean temperature of winter and summer, on the same parallel of latitude, and on the same isothermal line (that of Fort Wolcott being 50°.61, and that of Council Bluffs, 51°.02), is 14°.80 greater in an *excessive* than in a *uniform* climate.

As those who first observed the climatic difference between western Europe and eastern North America, were natives of the former, they of course regarded the climate of their own country as constituting the rule, and that of America as the exception; while some, even now, as, for instance, Lyell, as already quoted, make Europe the exception to the general rule. But when these facts came to be generalized, it was discovered that the eastern coasts of both continents have a lower annual temperature and more contrasted seasons than the western in corresponding latitudes. These results find a satisfactory explanation in physical causes; thus demonstrating the harmony of the laws of climate throughout the globe.

Did space allow, it would be easy to shew that the *rationale* of all these laws finds a ready explanation in the phenomena of the polar and equatorial currents, in connection with certain local causes. Suffice it to refer to a single explanation. The winds without the tropics have a prevailing direction from the west,—a fact which affords a solution of the problem that in extra-tropical latitudes, countries lying to the eastward of seas or other great bodies of water, have milder climates than those situated on the eastern portions of a continent. That this westerly breeze prevails with considerable regularity, is apparent from the following observations made by John Hamilton, during twenty-six voyages between Philadelphia and Liverpool, from 1798 to 1817, shewing that the winds were more than half the time from the west. Thus, out of 2029 days, the winds prevailed

From northward, . . .	208 days.
... southward, . . .	167 ...
... eastward, . . .	361 ...
... westward, . . .	1101 ...
Variable, ...	192 ...
	2029 days.

We thus perceive at once the principal cause of the rise of the isothermal line on the western coast of continents in extra-tropical latitudes; for there is thus swept from the ocean, which never sinks below the freezing point, a humid atmosphere, which, in its passage over the land, has a constant tendency to establish an equilibrium of temperature, and as its vapour is gradually condensed, it also evolves its latent heat. As large bodies of water never become so cold in winter, or so warm in summer, as the earth, the winds that sweep from them have a constant tendency to maintain an equilibrium of temperature. Land winds, on the contrary, must necessarily bear with them the greater or less degree of cold induced by congelation, while, in summer, they will convey the accumulated heat absorbed by the earth; and thus is produced, in a great measure, those extremes of the seasons which characterise extra-tropical latitudes on the eastern coasts of continents.

The difference of temperature on the eastern and western coast of continents is still further increased by local causes. Europe is separated from the polar circle by an ocean, while eastern America stretches northward at least to the 82° of latitude. The former, intersected by seas, which temper the climate, moderating alike the excess of heat and cold, may be considered a mere prolongation of the old world; while the northern lands of the latter, elevated from three thousand to five thousand feet, become a great reservoir of ice and snow, which diminishes the temperature of adjoining regions. "America," says Mr Phillips, "with little north tropical and wide polar land, gives us a case of extreme refrigeration from the pole towards the equator; Africa and the west of Europe compose a surface of wide and hot north tropical land, with free channels to a polar sea." Hence Lapland, under the 72°, experiences a less rigorous climate than Greenland under the 60th parallel. On the other hand, between the 40th parallel and the equator, the influence of land, if not very elevated, produces effects diametrically opposite; for the surface of the earth absorbs a large quantity of caloric, which is diffused by a radiation into the atmosphere. Thus Africa, as Malte-Brun observes, "like an immense furnace, distributes its heat to Arabia, to Turkey in Asia, and to Europe.'' On the contrary, the north-eastern extremity of Asia, which extends between the 60th and 70th parallel, and is bounded on the south by water, experiences extreme cold in corresponding latitudes.

Another cause contributing to the same effect is the Gulf Stream, the warm air arising from which being wafted by the westerly winds mainly to the shores of Europe. But independent of the westerly winds, which transport the tempered atmosphere of the Pacific over the land, and conversely, in traversing the continent, bear upon their wings the accumulating cold towards our eastern shores, we observe, in attempting to account for the extraordinary dissimilitude in the climate of our two coasts, on the eastern side an unascertained prolongation of the continent towards the pole, and an oceanic current sweeping immense masses of ice southwardly; while on the western side the great range of Rocky Mountains shelters Oregon from the polar winds, and the projecting mass of Russian America protects it from the polar ice.

Connected with this subject is the question frequently agitated, whether the old continent is warmer than the new. Volney and others have attempted its solution by a comparison of the mean annual temperatures of different places on both sides of the Atlantic; but to this mode of determining it, the objection at once presents itself, that the points of comparison represent opposite extremes in the climate of each continent. Indeed, the question in itself involves an absurdity; for as the laws of nature are unvarying in their operation, and as similar physical conditions obtain in corresponding parallels of both continents, the same meteorological phenomena will be induced. It shews in lively colours the truth of the remark, that every physical science bears the impress of the place at which it received earliest cultivation. In geology, for example, all volcanic phenomena were long referred to those of Italy; and in meteorology, the climate of Europe has been assumed as the type by which to estimate that of all corresponding latitudes. In making a comparison of the two continents, it is, therefore, necessary that both points have the same relative position. Fort Sullivan, Maine, notwithstanding it is more than 11° south of Edinburgh, Scotland, exhibits a mean annual temperature 5½° lower; Bordeaux, which is parallel with Fort Sullivan, has an annual temperature 15° higher; and the mean of Stockholm, in lat. 59° 20′, is about the same as that of Fort Sullivan, in lat. 44° 44′. These are not, however, legitimate points of comparison. Pekin and Philadelphia, each on the eastern coast of its respective continent, are fair examples, having the same latitude and a similar relative position, and consequently the same mean annual temperature. A comparison between western Europe and the United States would be equally improper with a comparison between it and China. "Thus at Pekin, in lat, 40° N., long. 116° 20′ E.," we are told,* "the mean temperature of summer is 78°·8, and of winter 23°—a difference of not less than 55°·8, which gives rise to a frost of several months' duration in that part of China; yet Pekin is under the same parallel as the southern extremity of Naples, where frost is unknown, and of the central provinces of Spain, in which, though at an elevation of two hundred feet above the sea, ice is an extremely rare occurrence."

Now, at Philadelphia, on an average of thirty-two years, the mean summer temperature is only 73°·17, and that of winter is as high as 32°·96, making a difference of 42°·21. Hence, as this difference is nearly 15° less at Philadelphia than at Pekin, and as the same result appears in the subjoined comparison of similar parallels in Oregon and in western Europe, it follows, contrary to general, indeed we may say *universal*, opinion, that the new world, so far from having a climate more austere than the old, has, in fact, if there really exists any difference, a more mild and uniform temperature.

It is only within the temperate zone, from 30° to 60° of north latitude, that the year exhibits the grateful vicissitudes of the four seasons—the varied charms of spring and autumn, the tempered fires of summer, and the healthful rigours of winter. Wisdom desires not that "eternal spring," the want of which poets affect to deplore. At the equator there is no difference between the mean temperature of summer and winter, but it increases, as a general rule, with the latitude. From Florida to Canada, the contrast in the seasons increases in proportion as the mean annual temperature decreases—a general law subject to modification on every parallel, in accordance with the varieties in physical geography. It has been already seen, that the greatest and the least contrasts of winter and summer are exhibited at Fort Snelling and Key West. Upon this point, Humboldt has, as usual, determined many important laws.

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* Encyclopædia Britannica.

"The winters of the isothermal curve of 68°," he says, "are not found upon that of 51°, and the winters of 51° are not met with on the curve of 42°." In considering separately what may be regarded as the same systems of climate, for example, the European region, the transatlantic region, or that of eastern Asia, the limits of variation become still more narrow. Wherever in Europe, in 40° of longitude, the mean temperature rises—

To 59°·00	the winters are from	44°·60 to 46°·40	and the summers from	73°·00 to 75°·00
To 54°·50		36°·50 to 41°·00		68°·00 to 73°·00
To 50°·00		31°·10 to 37°·40		62°·60 to 69°·80
To 45°·50		28°·40 to 36°·10		57°·20 to 68°·00
To 41°·00		20°·30 to 26°·80		55°·40 to 66°·00

In the United States, if the comparison is confined to the same system of climates, as, for example, the posts on the ocean or lakes, or those remote from the agency of large bodies of water, the limits of variation, as in Europe, are also narrow; but if the whole extent of our domain is embraced, the results are strikingly diverse. Thus—

	MEAN TEMPERATURE.		
	Annual.	Winter.	Summer.
Fort Vancouver, Oregon Territory,	51°·75	41°·33	65°·00
Council Bluffs, junction of Platte and Missouri, . . .	51°·02	24°·47	75°·82
Difference,	0°·73	+16°·86	—10°·82

Here, then, although there is not a degree of difference in the mean annual temperature of Fort Vancouver and Council Bluffs, yet the mean winter temperature of the latter is nearly seventeen degrees *lower*, while the mean summer temperature is nearly eleven degrees *higher*. But this contrast is exhibited in a still more marked degree by comparing the difference between the mean temperature of winter and summer, the former being 23°·67, while the latter is 51°·35.

"In tracing five isothermal lines between the parallel of Rome and St Petersburg," continues Humboldt, "the coldest winter presented by one of these lines is not found again on the preceding line. In this part of the globe, those places whose annual temperature is 54°·50 have not a winter below 32°, which is already felt upon the isothermal line of 50°."

In the European climate, two points having the same winter temperature may differ as much as 11° in latitude. Thus in Scotland, in latitude 57°, and isothermal line 45°·50, the winters are more mild than at Milan, in latitude 45° 28′, and isothermal line 55°·80. Consequently, the lines of equal winter cut isothermal lines which differ 10°. At the isle of Maggeroe, at the northern extremity of Europe, under the parallel of 71°, the winters are 7° milder than at St Petersburg, latitude 59° 56′. In the United States, embracing the whole region between the Atlantic and the Pacific, as great a contrast no doubt exists. The mean winter temperature of Fort Vancouver, Oregon Territory, latitude 45° 37′, is found about 9° farther south, at a point intermediate to Fort Gibson and Jefferson Barracks; but if the observations, like those in Scotland just referred to, were made on the coast (Fort Vancouver being seventy miles distant from the Pacific), the winter temperature would necessarily be still higher. As the mean annual temperature of Fort Vancouver is 51°·75, and that of the assumed point between Fort Gibson and Jefferson Barracks is about 61°, it follows that the lines of equal winter cut isothermal lines which differ more than 9° of Fahrenheit. (See Plate II.)

In Europe a greater deviation from the terrestrial parallels is caused by the inflections of the isocheimal than by the isothermal lines; for while two points having the same winter temperature may differ as much as 11° in latitude, a difference of not more than 5° is found between any two places having an equal annual temperature—disparities which increase as the eastern coast of Asia is approached. In the United States the same law obtains; for between the isothermal line of Fort Vancouver and the same in the Atlantic region, the difference is only 4° of latitude. (See Plate II.)

The isotheral curves or lines of equal summer follow a direction opposite to that of the isocheimal lines. The region about Moscow and that about the mouth of the Loire, in France, notwithstanding differing 11° in latitude, present the same summer temperature. Although this result, as regards difference of latitude, is not discovered in the United States, yet the most extraordinary results in this respect have been demonstrated on the same parallel running from the Atlantic through the great lakes. In the United States the heats of summer are everywhere intense. At Fort Snelling, notwithstanding the isocheimal line is 54° lower than at Key West, the isotheral is only 8° lower. (See Plate II.) At Fort Vancouver, the mean summer temperature is 2° or 3° higher than on the same parallel in the region of the Atlantic and the great lakes, and about 7° lower than in the excessive climates of the same region. In tracing an isothermal line around the globe, we find that the same causes which, on the Atlantic coast of North America and in the north of China, depress the curves of equal annual heat, tend to elevate the isotheral curves or lines of equal summer. Thus, in following the isothermal line of 51 around the globe, and adding the indications of the mean temperature of summer and winter at its summits and depressions, we find it marked in England, $\frac{37^\circ\cdot90}{62^\circ\cdot80}$; in Hungary, $\frac{31^\circ\cdot30}{70^\circ\cdot10}$; in China, $\frac{24^\circ\cdot10}{79^\circ\cdot20}$; in Western America, at Fort Vancouver, $\frac{41^\circ\cdot38}{65^\circ\cdot00}$; and in eastern America, at Council Bluffs, $\frac{24^\circ\cdot47}{75^\circ\cdot82}$; and at Fort Wolcott, Rhode Island, $\frac{32^\circ\cdot51}{69^\circ\cdot06}$.

The law, as established by Humboldt, *that the same causes which produce the greatest convexity of the isothermal line also equalize the temperature of the seasons*, has been already well illustrated in the table tracing the isothermal line of 55°·40 around the earth. The same isothermal curve, according to Humboldt, runs on the western coasts about six degrees of latitude higher than on the eastern; but to illustrate the law that at this *convex* point the seasons are most equalized, another table becomes necessary. Thus the annual mean temperature being equal to the fourth part of the total of the winter, spring, summer, and autumnal temperatures, the same isothermal line of 53°·60 shews—

	Winter. Spring. Summer. Autumn.
At the *concave* summit in America, 74° 40′ W. lon.	$53^\circ{\cdot}60 = \frac{32^\circ{\cdot}00 + 52^\circ{\cdot}30 + 75^\circ{\cdot}60 + 54^\circ{\cdot}50}{4}$
At the *convex* summit in Europe, 2° 20′ W. lon.	$53^\circ{\cdot}60 = \frac{40^\circ{\cdot}10 + 51^\circ{\cdot}80 + 68^\circ{\cdot}40 + 54^\circ{\cdot}10}{4}$
At the *concave* summit in Asia, 116° 20′ E lon.	$53^\circ{\cdot}60 = \frac{24^\circ{\cdot}80 + 54^\circ{\cdot}70 + 80^\circ{\cdot}60 + 54^\circ{\cdot}30}{4}$
At the *convex* summit in America, 122° 37′ W. lon.	$51^\circ{\cdot}75 = \frac{41^\circ{\cdot}33 + 48^\circ{\cdot}00 + 65^\circ{\cdot}00 + 52^\circ{\cdot}67}{4}$

The first three results on the same isothermal line are furnished by Humboldt. Unable to obtain the same annual temperature on our Pacific coast, it becomes necessary to take a lower isothermal line (that of Fort Vancouver in the "Army Meteorological Register") which, of course, gives a contrast in the seasons correspondently greater. It is thus seen that, on the western coasts, where the isothermal curve rises, or is *convex*, the seasons are much equalized, the difference between the mean temperature of winter and summer being only about one-half as great as on the eastern coasts, where the line sinks, or is *concave*. But this may be better illustrated by a tabular arrangement.

	Isothermal Line.		Diff. between Mean Temp. of Winter and Summer.
Asia, eastern coast,	53°·60	At depressions,	55°·80
America, eastern coast,	53°·60	...	43°·60
Europe, western coast,	53°·60	At Summits,	28°·30
America, western coast,	51°·75	...	23°·70

It may be well to add, that, with the exception of the last, the writer is not aware of the local position of these points of comparison—a consideration which may be supposed to be of some importance, inasmuch as the northern division of the United States presents, on the same isothermal line, a difference between the mean temperature of winter and summer, varying from 38° to 54°. This does not, however, in the least affect the law of the climatic analogy of the eastern and western continental coasts.

But this law, that the same causes which increase the mean annual temperature also equalize the seasons, does not hold good in the United States, in receding from the Atlantic; for, on comparing the climate of the coast of New England with the still more excessive climate of the interior, it is found that the mean annual temperature of the latter is higher. That the climate should become more austere, the seasons being *less* equalized, is in accordance with the laws established by Humboldt; but that the isothermal line, at the same time, should become more *convex*, is in diametrical opposition.

Forts Sullivan, Snelling, and Howard, for example, have very nearly the same latitude; the first, on the ocean, has a mean annual temperature of 42°·95, while the last two, in the opposite system of climate, have a mean respectively of 45°·83 and 44°·92—a result the more unexpected, at first sight, as the latter are in a region elevated six hundred to eight hundred feet above the level of the sea. Comparing Fort Wolcott, on the ocean, with Fort Armstrong, West Point, and Council Bluffs, in the interior, the same relation is found. Fort Trumbull, it is true, offers an exception; but it is necessary to bear in mind that the results of this post are based on two years' observation only, while those of Fort Wolcott are calculated from ten; and in further evidence of its probable erroneousness, it may be mentioned that the mean annual temperature at Fort Columbus, which is 0° 40′ farther south than Fort Trumbull, based on nine years' observation, is 2° less. Again, we find that while at Salem, near the Atlantic, in lat. 42° 34′, the mean annual temperature, based on thirty-three years' observations, is 48°·61, it is, on the other hand, at Fort Armstrong, lat. 41° 28′, Council Bluffs, lat. 41° 45′, and at West Point, lat. 41° 22′, respectively 51°·63, 50°·50, and 52°·47. Here, then, is actually an increase of from two to four degrees in the annual temperature, while the interior posts are only about

1° nearer the equator, which cannot, on the average, cause a greater difference of temperature than 1°·50.

Having thus shewn that there is an actual increase of annual temperature, or a rise of the isothermal line, on receding from the Atlantic, it is deemed unnecessary to give any details proving, that instead of the seasons becoming, from the same causes, more equalized, they actually grow more contrasted, inasmuch as this law has been already abundantly established. Suffice it to compare Fort Snelling on the Mississippi and Fort Sullivan on the Atlantic. Although the former has a mean annual temperature 2°·88 higher than that of the latter, yet it has a contrast between the mean temperature of winter and summer actually 17°·45 greater! Equally striking is the contrast between the results given by posts on the lakes and those in the same region, notwithstanding not more than one, two, or three hundred miles distant. Thus, on comparing Fort Snelling and Howard with positions (Forts Brady and Mackinac) in the modified climate of the lakes, this relation is discovered; for, although the mean latitude of the latter posts is only 1° 34′ north of Fort Snelling (and, perhaps, four hundred miles distant), yet the mean annual temperature is 4°·25 lower. Now, of this difference in annual temperature, not more than one-half can be accounted for by difference of latitude, being an expression of the same law that was revealed by the comparison with posts modified by the ocean; and we also find, that, so far from the temperature of the seasons being more equalized at Fort Snelling, which has a higher annual temperature, the difference between the mean temperature of summer and winter is, in reality, 12°·84 greater than on the lakes.

Humboldt's law holds good so far as the comparison refers to the eastern and western continental coasts, each being more or less modified by the ocean; but in a comparison with an interior position remote from large bodies of water, a new element, arising from the law of the accumulation of caloric by the surface of the earth, doubtless enters into the calculation. It may be said, however, that this ought to be compensated by the augmented cold of winter; but it is found in our excessive climates, compared with the modified, that the annual temperature gains more by the continued elevation of the thermometer in summer, than it loses by its depression in winter. Besides, in excessive climates, the vernal increase alone often compensates for the low temperature of winter; for example, although the mean winter temperature at Fort Sullivan is 22°·95, and at Fort Snelling as low as 15°·95, yet that of spring is higher at the latter, being as 46°·78 to 40°·11. Then follows a mean summer temperature more than 10° higher in the excessive than in the uniform clime. The season of autumn (September, October, and November) is not perceptively influenced by these causes.

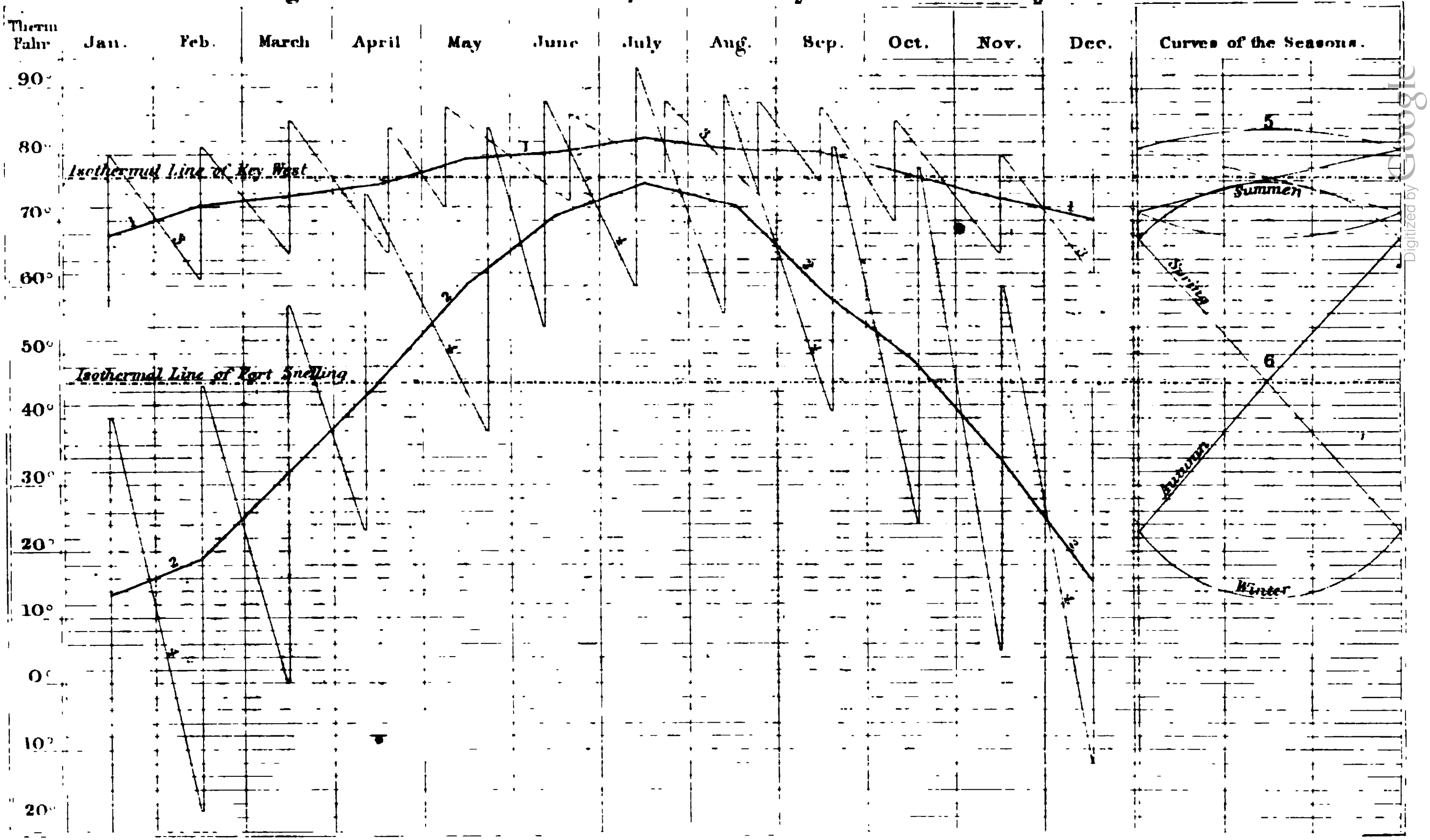
These contrasts would be still more striking were the comparisons instituted between points on the same isothermal line, instead of the same parallel of latitude; for, as the isothermal curve of Fort Sullivan would strike a point at least 2° north of Fort Snelling, the extremes of the seasons there would be correspondently augmented. Sufficient, however, has been adduced to prove, that Humboldt's deduction, *that the same causes which produce the greatest convexity of the isothermal line, also equalize the temperature of the seasons*, is unwarranted as a general law. And here the writer may venture to add that these conclusions pertain wholly to himself, inasmuch as they had been, doubtless, never brought to the notice of the scientific world, before they were made known by him in his work on "The Climate of the United States, and its Endemic Influences."

These results, in the comparisons just made, appear the more extraordinary, as some reduction of temperature, by reason of the elevation of these interior posts, would be *à priori* inferred; for, according to Humboldt, "elevations of four hundred metres, (one thousand three hundred and twelve feet,) appear to have a very sensible influence on the mean temperature, *even when great portions of countries rise progressively*." That high table-lands have a more exalted temperature than isolated mountains of the same height is well known; for the elevated plains on which the towns of Bogota, Popayán, Quito, and Mexico are built, have a much warmer climate than they would have, if elevation above the sea were the only element that determines the temperature when the latitude is given. That our western table-lands, rising gradually to the height of eight hundred feet, cause no diminution of temperature, has been already abundantly established.

Without attempting here to explain the diminution of temperature on the summits of high mountains, it may be remarked that these causes cannot be in operation when a large region of country rises very slowly and progessively to a height less than one thousand feet. It is only when lands are considerably and suddenly elevated, and exposed to the action of the atmosphere laterally, that a rapid conduction of heat and rarefaction of the atmosphere can take place. Our north-western region, in those districts which are remote from the great lakes, so far from causing a diminution of annual temperature, produces, it has been seen, an augmentation.

In regard to the extremes of heat and cold in the United States, it would be natural to expect that the severest cold would be registered at the most northern, and the greatest heat at the most southern posts. It is now, however, proved, by exact instrumental observations, that this is not the case, as these are situated on large bodies of water; but that the western stations, Forts Snelling, Gibson, and Council Bluffs, remote from inland seas, are remarkable for extremes of temperature. It is here that the mercury rises the highest and sinks the lowest, while Forts Brady and Mackinac, the most northern stations, as well as those on the southern coast, exhibit a lesser range of thermometer; and in accordance with the same law, we find that the mean summer temperature is greater at Augusta, Georgia, than along the coast of Florida. While at Key West, during a period of six years, the thermometer never rose above 90°, it attained at Council Bluffs, a point 17° 12′ farther north, a height every year varying from 102° to 108°. The highest temperature in the shade noted at various posts, was at Fort Gibson, on the 15th of August 1834, being 116°. In Africa, the mercury is sometimes seen at 125°, and in British India

Exhibiting the different Laws of Temperature at Key West & Fort Snelling.



it is said to have been as high as 130°. It has been remarked that on the coast of Senegal the human body supports a heat which causes spirits of wine to boil, and that in the north-east of Asia, it resists a cold which renders mercury solid and malleable. Although the mean annual temperature, in proceeding from the equator toward the poles, gradually, diminishes, yet the thermometer scarcely mounts higher at the equinoctial line than under the polar circle. Hence it follows, that the climate of the tropics is characterized much more by the duration of heat than its intensity.

(To be concluded in our next Number.)

On the Physiognomy of the Surface of the Earth. By Baron Alexander von Humboldt.

The recent progress of geognosy, or, in other words, the extended knowledge of those *geognostical epochs* which are characterised by mineralogical differences in the rock-formations, by the peculiarity and succession of the organisms they include, and by relative position (the elevation, or the undisturbed horizontality of the strata), leads us, in following the causal connection of the phenomena, to the consideration of the *distribution of the solid and the liquid portions*, that is to say, of the continents and the seas which form the surface of our planet. We here refer to a point of connection between historical and geographical geognosy, to the whole consideration of the conformation and horizontal configuration of continents. The boundary of the solid by the liquid parts, or the areal relation of the one to the other, has been very various during the course of the long succession of geognostical epochs; according as the strata of the coal formation were deposited on the elevated strata of the mountain limestone and the old red sandstone; the Lias and Jura formations on the shores of the *Keuper* and *Muschelkalk;* or the chalk on the declivities of the Greensand and the Jura limestone. If, following Elie de Beaumont, we designate by the term *Jura* and *Chalk seas*, the waters under which the Jura limestone and chalk were precipitated in a muddy condition, then the outlines of these two formations indicate, for two epochs, the boundary between the still stone-producing ocean and the solid land which had previously been laid dry. The ingenious idea has been suggested, of preparing maps of this physical portion of *ancient geography;* maps which, perhaps, are more trustworthy than those of the wanderings of Io or those of the Homeric geography. The latter exhibit opinions and mythological representations; the former present the earliest facts of the positive doctrine of formations.

The result of investigations regarding the superficial relations of dry land is, that in the earliest periods, viz. in the Silurian and Devonian transition-epoch, as well as in the first floetz period, including the trias, the uncovered surface which was clothed by land plants, was limited to detached islands; that afterwards these islands were united with one another, and included many lakes along the deeply penetrating bays of the sea; and, lastly, that when the mountain chains of the Pyrenees, the Apennines, and the Carpathians were elevated, therefore at the period of the deposition of the older tertiary strata, vast continents, having nearly their present size, made their appearance. In the Silurian world, as well as during the period characterised by a profusion of Cycadeæ and by gigantic Saurians, the amount of dry land from pole to pole was probably less than it is at present in the South Sea and the Indian Sea. I shall afterwards explain how this excessive prevalence of water, in combination with other causes, contributed to the elevation of temperature, and to the greater uniformity of climate. At present it is only necessary to remark, in considering the gradual enlargement (agglutination) of the elevated dry tracts of land, that shortly before the revolutions which, after shorter or longer pauses, produced, during the *diluvial period*, the sudden destruction of so many gigantic vertebrate animals, portions of the now existing continental masses were then completely separated from one another. Great similarity prevails in South America and Australia between the living and the extinct animals. In New Holland, fossil remains of kangaroos have been discovered; and in New Zealand, semifossil bones have been found of an enormous ostrich-like bird (Owen's Dinornis), which is nearly related to the Apteryx of the present day, and is but little connected with the Dodo of the island of Rodriguez, so lately become extinct.

The present configuration of the continents probably owes its elevation above the surrounding seas, chiefly to the eruption of quartziferous porphyries; an eruption which affected so powerfully the first great terrestrial flora,—that flora which afforded the material for coal. What we term the plains of continents, are only the broad ridges of hills and mountains, whose bases are situated at the bottom of the sea. Every *plain* is, according to its submarine relations, a *table-land*, whose inequalities are concealed by new sedimentary formations deposited in a horizontal position, and by alluvial matter.

Among the general considerations belonging to the extended view we are now taking of our globe, the first rank is to be assigned to the *quantity* of elevated solid land which projects above the sea; and to this determination of the amount, there then succeeds the consideration of the individual *configuration with reference to the horizontal extension* (the relations of the division of parts: *Gliederungs-Verhältnisse*), or *with reference to the perpendicular elevation* (the hypsometrical relations of mountain-chains.) Our planet has two envelopes, a general one, the atmosphere, an elastic fluid; and a particular one, only locally distributed, which bounds the solid land and thus affects its form, viz., the sea. Both envelopes of our planet, the air and the sea, form *a natural whole*, which gives rise to the diversity of climate of the earth's surface: according to the amount of the relative extent of sea and land, the horizontal division (*Gliederung*) and position of the solid land, and the direction and height of the mountain chains. It results from this knowledge of the mutual action of the *air*, the *sea*, and the *land*, that great meteorological phenomena cannot be understood, if separated from geognostical considerations. Meteorology, like the geography of plants and animals, has only begun to make progress since observers became convinced of the mutual dependence of the fundamental phenomena. The word *climate* no doubt means, in the first instance, a particular state of the atmosphere; but this condition of the atmosphere is dependent on the continual *combined action* of *the sea*, which is everywhere agitated to a great depth, and is traversed by currents having entirely different temperatures, and of *the dry land*, which radiates heat, exhibits all varieties of horizontal configuration, elevation, and colour, and is either bare or covered with woods and plants.

In the present state of the surface of our planet, the area of the solid land bears to that of the sea the proportion of 1 to $2\frac{4}{5}$ (according to Rigaud* of 100 to 270.) The islands form scarcely $\frac{1}{23}$ of the continental masses. The latter are so unequally distributed, that they form three times as much land in the northern hemisphere as in the southern. The southern hemisphere, therefore, is peculiarly and predominantly oceanic. From 40° S. L. to the antarctic pole, the crust of the earth is almost entirely covered with water. The liquid element is just as predominant, and is only interrupted by widely-scattered groups of islands, between the east coast of the old and the west coast of the new world. The learned hydrographer, Fleurieu, has very properly distinguished this vast basin of the sea by the name of the *great ocean*. Within the tropics, it includes a space of 145° of longitude. The southern and western hemispheres (reckoning westward from the meridian of Teneriffe) are, therefore, the regions containing the most water of the whole surface of the globe.

These, then, are the principal facts regarding the relative *quantity* of the solid land and the sea, a relation which so powerfully influences the distribution of temperature, the variations in the pressure of the air, the direction of the winds, and the amount of moisture in the atmosphere,—the last being a feature which acts very essentially on vegetation. When we reflect that an extent of nearly three-fourths of the surface† of our planet is covered with water, we are the less surprised at the imperfect state of meteorology up to the present century: an epoch in which, for the first time, a considerable number of accurate observations on the temperature of the sea in different latitudes, and in different seasons, were obtained, and numerically compared with one another.

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* Transactions of the Cambridge Philosophical Society, vol. vi. P. 2, 1837, p. 297. According to other authorities the proportion is as 100 : 284.

† During the middle ages an opinion prevailed that the sea covered only the one-seventh part of the surface of the earth; an idea which Cardinal

The horizontal configuration of the solid land, considered with regard to the most general relations of its extension, was a subject of ingenious investigation in the early periods of Grecian antiquity. The maximum of its extension from west to east was investigated, and Dicearchus, according to the testimony of Agathemerus, determined it to be in the latitude of Rhodes, in a direction running from the Pillars of Hercules to Thinæ. This is the line which has been termed *the parallel of the diaphragm of Dicearchus*, and the astronomical accuracy of whose position (investigated by me elsewhere) must be regarded with astonishment.* Strabo, guided probably by Eratosthenes, seems to have been so convinced that this parallel of 36°, regarded as the maximum of the extension of the world known to him, had an internal cause of configuration, that he predicted the existence, in the same latitude, of the solid land whose presence he prophetically conjectured in the northern hemisphere between Iberia and the coast of Thinæ.†

While, as we have already remarked, a considerably larger portion of land has been elevated above the level of the sea in the one hemisphere of the earth than in the opposite (whether the globe be halved through the equator, or through the meridian of Teneriffe); both the great masses of land, which

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D'Ailly (*Imago Mundi, cap.* 8) founded on a passage in the Apocrypha. Columbus, who always drew his cosmological knowledge from the works of the Cardinal, had a great interest in defending this opinion as to the smallness of the sea, to which, no doubt, the misunderstood expression of the "River Ocean" had led. *Vide Humboldt, Examen Critique de l'Hist. de la Géographie,* t. i. p. 186.

* Agathemerus in Hudson, *Geographi Minores,* t. 2, p. 4. *Vide Humboldt, Asie Centr.,* t. i., pp. 120, 125.

† *Strabo,* lib. i., p. 65. *Casaub.* *Vide Humboldt, Examen Crit.,* t. i., p. 152.

are, in fact, true islands, surrounded by the ocean on all sides, and which we term the *eastern* and *western* or the *old and new continents*, exhibit, along with the most striking contrasts in their total configuration, or rather in the *position of their larger axes*, considerable resemblance in the details of their arrangement, and more especially in the superficial relations between the coasts which stand opposite to one another. In the eastern continent, the prevailing direction, or the position of the *long axis*, is from east to west (more correctly from SW. to NE.); whereas, in the western continent, it is from S. to N., like that of meridians, (more exactly from SSE. to NNW.). Both masses of land are cut off to the north in the direction of a parallel of latitude (chiefly in that of 70°), and to the south they project in pyramidal points, for the most part with a submarine continuation of islands and reefs. This is exhibited in the archipelago of Terra del Fuego; in the Lagullas-Bank, south of the Cape of Good Hope; and in Van Diemen's Land, which is separated from New Holland by Bass's Strait. The Northern Asiatic coast projects beyond the above mentioned latitude at Cape Taimura (78° 16′ according to Krusenstern); while, from the mouth of the great river Tschukotschja eastward towards Behring's Straits, it reaches only latitude 66° 3′, according to Beechy, at the most eastern promontory of Asia, the East Cape of Cook.* The northern coast of the New Continent follows pretty exactly the parallel of 70°, because southward and northward from Barrow's Straits, from Boothia Felix and Victoria Land, all the land consists only of detached islands.

The pyramidal form of all the southern terminations of the continents is one of the *similitudines physicæ in configuratione mundi* to which Bacon (Lord Verulam) directed attention in his *Novum Organum*, and with which Reinhold Forster, the companion of Cook on his second voyage round the world, connected some ingenious views. If we proceed eastward from the meridian of Teneriffe, we find that the terminations of the three continents, viz., the southern terminations of Africa (the extremity of the whole ancient world), of Australia, and of South America, gradually approach the South Pole. New Zealand, which is fully 12° of latitude in length, forms, with great regularity, an intermediate link between Australia and South America, ending also with an island (New Leinster). It is a remarkable fact, that almost precisely in the same meridians in which the terrestrial mass of the old continent attains its greatest extension to the south, the northern coast also advances most nearly to the North Pole. This is a result of the comparison of the Cape of Good Hope and the Lagullas Bank with the European North Cape, and of the Peninsula of Molucca with the Siberian Cape Taimura.[*] Whether the two poles of the globe are surrounded by a zone of solid land, or only by an icy sea covered with floetz beds of ice, is unknown to us. Towards the North Pole, latitude 82°.55′ has been reached; and towards the South Pole, only that of 78° 10′.

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* On the subject of the mean latitude of the North Asiatic Coast, and the correct designation of Cape Taimura (Cape Siewero—Wostotschnoi) and North-east Cape (Schalagskoi Mys), *vide Humboldt, Asie Centrale*, t. iii., pp. 35, 37.

Just as the great masses of land terminate pyramidally, so the same configuration is repeated, and with great variety, on the small scale, not only in the Indian Ocean (in the peninsulas of Arabia, Hindostan, and Malacca), but also, as was pointed out by Eratosthenes and Polybius, in the Mediterranean, where the Iberian, Italian, and Hellenic Peninsulas, were judiciously compared by these ancient authors.[†] Europe, with an area five times smaller than that of Asia, is also only a western and much divided peninsula of the Asiatic undivided continent; and the climatological relations of Europe prove, that it occupies the same position in regard to Asia, which Peninsular Brittany does in regard to the rest of France.[†] Strabo had already remarked the manner in which the horizontal division of a continent, or the higher development of its form, operates as well on the civilization as on the whole state of cultivation of nations; for he ascribes peculiar advantages to the very varied configuration of our small continent.* Africa† and South America, which, in other respects also, exhibit so close a resemblance in their configuration, have, of all the great masses of land, the simplest form of coasts. It is only the eastern coast of Asia which, being, as it were, broken up by the eastern currents of the sea‡ (*fractus ex æquore terras*), presents a configuration of a very varied nature. There we have peninsulas and neighbouring islands alternating with one another from the equator to lat. 60°.

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[*] *Asie Centrale*, t. i., pp. 198-200. The southern extremity of America also, together with the Archipelago of Tierra del Fuego, is situated in the meridian of the most northern portion of Baffin's Bay and of the Great Polar Land, which probably belongs to West Greenland.

[†] *Strabo*, lib, ii., pp. 92, 108, *Casaub.*

[†] Humboldt, *Asie Centrale*, t. iii., p. 25. So early as 1817, in my work, *De Distributione Geographica Plantarum secundum Cœli Temperiem et Altitudinen Montium*, I directed attention to the distinction which is so

The Atlantic ocean presents all the characters of a *great*

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important to climatology and human civilization, of continents having uniform, and those having indented coasts:—"*Regiones vel per sinus lunatos in longa cornua porrectæ, angulosis littorum recessibus quasi membratim discerptæ, vel spatia patentia in immensum, quorum littora nullis incisa angulis ambit sine anfractu Oceanus*" (pp. 81 and 182.) With regard to the relation of the extent of coasts to the area of the continent (which is, at the same time, the measure of the accessibility of the interior), see my investigations in *Berghaus Annalen der Erdkunde*, vol. xii., 1835, p. 490, and *Physikal. Atlas*, 1839, No. 3. p. 69.

* Strabo, lib. ii., p. 126, *Casaub.*

† Pliny, (v. i.) says of Africa—*Nec alia pars terrarum pauciores recipit sinus.* The small Indian peninsula on this side of the Ganges, with its triangular shape, also presents a third very analogous form. In the ancient literature of Greece, opinions prevailed of a *regular* configuration of the solid land. It was said that there were four gulfs, of which the Persian was placed opposite to the Hyrcanian (*i. e.* to the Caspian Sea)—(Arrian, vii., 16; Plut. *in Vita Alexandri*, cap. 44; Dionys. Perieg., v., 48, and 630, pp. 11 and 38, *Bernh.*) The four gulfs and the isthmuses were even alleged, according to the optical fancies of Agesianarus, to be reflected on the disc of the moon (*Plut. de Facie in Orbe Lunæ*, pp. 921, 19.) Regarding the *terra quadrifida*, or the four solid lands, of which two were said to lie to the north, and two to the south, of the equator, see Macrobius, *Comm. in Somnium Scipionis*, ii., 9. I have subjected this portion of ancient geography, as to which much perplexity prevails, to a new and careful examination, in my *Examen Crit. de l'Hist. de la Geogr.* t. i., p. 119, 145, 180–185; and also my *Asie Centrale*, t. ii., pp. 172-178.

‡ Fleurieu in the *Voyage de Marchand Autour du Monde*, t. iv., pp. 38–42.

valley. It would seem as if, in its case, a flood of water had directed its violence, first towards the north-east, then towards the north-west, and then again towards the north-east. The parallelism of the coasts to the north of 10° of south lat., the salient and re-entering angles, the convexity of Brazil opposite the Gulf of Guinea, and the convexity of Africa in the same latitude with the Gulf of the Antilles, are all in favour of this apparently bold idea.* In the Atlantic valley, as is the case almost everywhere with the configuration of great masses of land, coasts which are indented and abound in islands are placed opposite to those which are of a uniform character. I have long since directed attention to the geographical interest of a comparison of the west coasts of Africa and South America in the tropical zone. The gulf-like indentation of the African shore at Fernando Po (north lat. 4¼°), is repeated on the shore of the South Sea, in south lat. 18¼°, near Arica, where (between the Valle de Arica and the Morro de Juan Diaz) the Peruvian coast suddenly alters its direction from a south and north one to a north-western one. This change of direction extends, in an equal degree, to the two parallel ranges of the chain of the Andes: not only in the littoral† high land, but also in the eastern, which was the earliest seat of human cultivation in South America, and where the alpine Lake of Titicaca is bounded by the colossal mountains of Sorata and Illimani. Further to the south, from Valdivia and Chiloe (south lat. 40° to 42°), through the Archipelago *de los Chonos*, as far as Tierra del Fuego, we find again repeated the peculiar *fiord*-arrangement (the complication of narrow and long indentations) which, in the northern hemisphere, is characteristic of the west coasts of Norway and Scotland.

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* Humboldt in the *Journal de Physique*, t. liii., 1799, p. 33, and *Rel. Hist.*, t. ii., p. 19; t. iii., pp. 189 and 198.

† Humboldt in *Poggendorff's Annalen der Physik*, vol. xl., p. 171. As to the remarkable Fiords of the south-east extremity of America, see Darwin's Journal (Narrative of the Voyages of the Adventure and Beagle, vol. iii.), 1839, p. 266. The parallelism of the two mountain-chains continues from 5° south lat. to 5° north lat. The change of the direction of the coast near Arica appears to be the consequence of the *altered strike* of the fissure through which the *Cordillera de los Andes* has been elevated.

The preceding are the most general considerations regarding the present configuration of Continents (the extension of the solid land in a horizontal direction), which result from a survey of the surface of our planet. We have placed together the facts on this subject, and the analogies of the form of remote portions of the earth, which, however, we do not venture to term *laws of the form*. When we observe on the slope of an active volcano, as, for example, on Vesuvius, the not unfrequent phenomenon of partial elevations, in which small portions of the surface, previous to or during an eruption, have their level changed to the amount of several feet, and give rise to roof-like ridges, or to flat eminences; we perceive that the elevated portions assume this or that form and direction, in consequence of trifling accidental differences in the intensity of the subterranean action of the vapours, and of the extent of resistance to be overcome. In the same manner, inconsiderable disturbances in the equilibrium of the interior of our planet may have caused the elevating elastic forces to have acted more towards the northern than towards the southern half of the earth, and to have forced up the solid land in the *eastern* hemisphere in the form of a broad connected mass, having its principal axis nearly parallel to the equator, and in the *western* and more oceanic half of the earth in the form of a narrow mass, having the direction of meridians.

But little can be ascertained empirically respecting the causal connection of these leading points in the formation of the dry land—of the resemblances and contrasts of its configuration. We know only this much: that the operating cause is subterranean; that the present form of the land was not produced at once, but that, from the epoch of the formation of the Silurian rocks, up to that of the deposition of the Tertiary strata, the land was gradually increased and united together by the blending of individual and smaller continents, after the occurrence of a variety of oscillating elevations and sinkings of the surface. The present configuration is the result of two causes, which have operated consecutively,—in the *first* place, a subterranean manifestation of power, whose amount and direction we term *accidental*, because we are not able to determine them, and because, in so far as our comprehension is concerned, they are removed from the sphere of *necessity;* and, in the *second* place, the forces acting at the surface, of which volcanic eruptions, earthquakes, and the production of mountain-chains and marine currents, have performed the chief part. How entirely different would the condition of the temperature of the earth, and with it that of vegetation, of agriculture, and of human society, have been, if the principal axis of the new Continent had been placed in the same position as that of the old,—if the chain of the Andes, instead of having a meridian-like direction, had risen up from the east towards the west,—if to the south of Europe there had been no tropical land (Africa) radiating heat,—if the Mediterranean Sea, which, at one period stood in connection with the Caspian and Red Seas, and exercised so powerful an influence on the progress of human civilization, had not existed,—and if the bottom of that sea had been elevated to the same height as the plains of Lombardy and Cyrene!

The changes in the relative heights of the liquid and solid portions of the surface of the earth (changes which, while they determine the outlines of the continents, lay dry or submerge the low lands) are to be ascribed to the action of many non-contemporaneous causes. The most powerful of these have undoubtedly been the force of the elastic vapours which are contained in the interior of the earth; the sudden *alteration of the temperature** of immense beds of rock; the unequal secular loss of heat of the crust and nucleus of the earth, produced by an elevation (literally folding or wrinkling—*Faltung* or *Runzelung*) of the solid surface; and local modifications of the power of attraction,* and the resulting altered curvature of a portion of the liquid element. It appears, according to the opinion now generally entertained by geologists, and which is founded on the long-continued observation of connected facts, as well as on the important analogy of volcanic phenomena, that the *elevation of continents* is a *real,* and not merely an apparent, elevation. The merit of this view belongs to Leopold von Buch, who stated it, and first introduced it into science, in the narrative of his important journey through Norway and Sweden, performed in the years 1806 and 1807.† Although the whole coast of Sweden and Finland is rising (upwards of four English feet in a century) from the boundary of northern Schonen (Sölvitsborg) to Gefle, and thence as far as Torneo, and from Torneo to Abo, yet, on the other hand, according to Nilson, southern Sweden is sinking.‡ The maximum of the elevating force seems to be in northern Lapland. The rising gradually diminishes towards the south as far as Calmar and Sölvitsborg. Lines marking the ancient level of the sea, in pre-historical periods, are indicated by beds of shells belonging to the sea of the present day throughout the whole of Norway,* from Cape Lindesnäs to the North Cape; and very recently their height has been accurately measured by Bravais, during a long winter residence in Bosekop. They are placed 640 English feet above the present mean level of the sea; and they also occur, according to Keilhau and Eugene Robert, on the coasts of Spitzbergen, opposite the North Cape (to the NNW.) Leopold von Buch, who was the first to direct attention to the high bed of shells at Tromsoe (lat. 69° 40′), has shewn that the more ancient elevations on the North Sea belong to a different class of phenomena from the gentle (not sudden or jerking) rising of the Swedish coast in the Bothnian Gulf. Nor must the latter phenomenon, so well established by historical evidence, be confounded with the change of level produced by earthquakes (such as is observed on the coasts of Chili and Cutch). Very lately the Swedish phenomenon has given rise to analogous observations in other countries. A perceptible *sinking* is sometimes met with, corresponding to the rising, as a consequence of the folding or plaiting (*Faltung*) of the strata; this is the case in West Greenland (according to Pingel and Graah), in Dalmatia, and in Schonen.

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* De la Beche's Sections and Views, 1830, Plate xl.; and Babbage's Observation on the Temple of Serapis, 1834. "A mass of sandstone, five English miles in thickness, when heated to 100° Fahr., would have its surface raised to an extent of 25 feet. Heated strata of clay, on the other hand, must, by contraction, produce a sinking of the surface." *Vide* the calculations as to the secular rising of Sweden, on the supposition of the small increase of 3°. R., in a mass of rock 140,000 French feet thick, heated to the melting point, in Bischof's *Wärmelehre der Innern unseres Erdkörpers,* p. 303.

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* Vide *Bessel über Maass und Gewicht*, in *Schumacher's Jahrbuch* for 1840, p. 134.

† Vol. ii. (1810), p. 39. See also Hallström, in *Kongl. Vetenskaps-Academiens Handlingar* (Stockholm), 1823, p. 30; Lyell, in Philosophical Transactions for 1835, p. 1; and Blom's *Statistische Beschreibung von Norwegen*, 1843, pp. 89—116. Although in 1802, Playfair, in his Illustrations of the Huttonian Theory, § 393, and, as Keilhau reminds us (*Om Landjordens Stigning in Norge,* in the *Nyt Magazin for Naturvidenskaberne),* Jessen the Dane, previously to Playfair, both expressed the conjecture that the sea does not sink, but that the solid land of Sweden rises; yet these suggestions were entirely unknown to our great geologist Von Buch, and exercised no influence on the progress of physical geography. Jessen, in his work, entitled *Kongeriget Norge fremstillet efter dets naturlige og borgerlige Tilstand; Kjöbenh.* 1763, supported his idea of the causes of the change of the relative level of the sea and coasts by the old statements of Celsius, Kalm, and Dalin. He also advances some confused notions regarding the possibility of an internal growth and increase of stones (of the rocky surface); but at last declares himself to be in favour of the elevation of the land being a consequence of earthquakes. He says,—"Although, immediately after the earthquake (at Egersund), no such elevation was remarked, yet other causes may thus have been afforded for producing it."

‡ *Berzelius' Jahresbericht über die Fortschritte der physichen Wissenschaften,* No. 18, p. 686. The islands of Saltholm, opposite Copenhagen, and Bornholm, are rising very slightly; Bornholm scarcely one foot in a century. See Forchhammer in the Phil. Mag., series 3, vol. ii., p. 309.

Since it must be considered as extremely probable, that in the early periods of our planet, the oscillating movements, that is to say, the rising and sinking, of the surface, were more intense than they are at present, we should feel the less surprised at finding, in the interior of continents, detached portions of the earth's surface which occupy a lower position than the present general level of the sea. Examples of this kind are afforded by the Natron Lakes described by

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* Keilhau in the *Nyt. Mag. for Naturvid.* 1832, vol. i., pp. 105—254; and vol. ii., p. 57; Bravais *sur les lignes d'ancien niveau de la Mer*, 1843, pp. 15—40; and also Darwin on the Parallel roads of Glen-Roy, in the Phil. Transactions for 1839, p. 60.

General Andreossy, by the small bitter lakes in the Isthmus of Suez, by the Lake of Tiberias, and, above all, by the Dead Sea.* The level of the waters of the two last mentioned lakes is 666 and 1812 English feet lower than the surface of the Mediterranean Sea. If we could suddenly remove the alluvial matter which covers the strata of rock in so many level parts of the earth, it would become manifest how many portions of the solid surface of the globe at present occupy a lower level than the surface of the ocean. The periodical, although irregularly alternating, rise and fall of the Caspian Sea, of which I have myself seen distinct traces in the northern portion of that basin, appears to prove† (as is also shewn by the observations made by Darwin in the coral seas),* that, without the occurrence of any actual earthquake, the surface of the earth is still subjected to the same gentle and progressive oscillations, which were of such general occurrence in early periods, when the thickness of the indurated crust of the earth was less considerable.

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* *Humboldt, Asie Centrale*, t. 2, pp. 319-324; t. 3, pp. 549-551. The depression of the Dead Sea has been gradually ascertained through means of the barometrical measurements of Count Bertou, the much more careful measurements of Russegger, and the trigonometrical measurement of Lieutenant Symonds of the English navy. The last mentioned observer, in a letter addressed by Mr Alderson to the Geographical Society of London, and communicated to me by my friend Captain Washington, has stated that the difference of level of the surface of the Dead Sea and of the highest house in Jaffa is 1605 English feet. Mr Alderson believed at that time (November 28, 1841), that the Dead Sea was about 1400 English feet below the level of the Mediterranean. In a more recent communication by Lieutenant Symonds (Jameson's Journal, vol. xxxiv. p. 178), the amount of 1312 English feet is given as the final result of two trigonometrical operations agreeing very nearly with each other.

† *Sur la Mobilité du fond de la Mer Caspienne* in my *Asie Centrale*, t. ii., pp. 283-294. At my request, the Imperial Academy of Sciences of St Petersburg, in 1830, caused the learned natural philosopher Lenz to cut fixed marks at particular points (indications shewing the mean level of the water at a certain epoch) at Baku, in the Peninsula of Abscheron. In 1839 also, in a supplement to the instructions given to Captain Ross for the Antarctic expedition, I urged that marks should be cut in the rocks of the southern hemisphere, wherever there was an opportunity, in the same manner as in Sweden and on the shores of the Caspian Sea. If this had been done in the early voyages of Bougainville and Cook, we should now know if the secular alteration of the relative heights of the sea and land is to be regarded as a general, or only as a local, natural phenomenon; and if a law can be recognized as to the direction of the points which rise and sink simultaneously.

The phenomena on which I have now endeavoured to fix attention, remind us of the mutability of the present order of things, and of the changes which the outline and configuration of continents have probably undergone in the course of long intervals of time. That which is hardly perceptible to immediately following generations, becomes accumulated in periods, of the length of whose duration a measure is afforded to us by the movement of the heavenly bodies. The eastern coast of the Scandinavian Peninsula has probably risen upwards of 340 English feet in eight thousand years; and if the movement should prove to be uniform, portions of the bottom of the sea, which lie near the coast of the peninsula, and are at present still covered by a stratum of water 50 fathoms (Brassen) in thickness, will make their appearance at the surface, and begin to be laid dry in twelve thousand years. But what is the shortness of these intervals of time, when compared with the duration of geognostical periods, which display to us the succession of formations, and the hosts of entirely different extinct organisms! In the same manner as we have now been contemplating the phenomenon of elevation, we may also, supported by the analogies of observed facts, assume the possibility of a similar amount of sinking, or, in other words, of the depression of whole tracts of land. The *mean* height of the non-mountainous portion of France does not quite amount to 480 French (511½ English) feet. When compared with ancient *geognostical periods*, during which greater changes took place in the interior of the globe, a very long time would not therefore be requisite for the submersion of a considerable portion of the north-west of Europe, and for the outlines of its coast presenting an entirely different configuration from their present one. The sinking and rising of the solid and liquid portions of the surface of the earth, which are so opposed to each other in their individual operations, that the rising of the one produces the apparent sinking of the other, are the cause of all the changes of the form of continents. In a general view of physical facts, and in an unbiassed and not one-sided statement of natural phenomena, the *possibility* at least of a diminution of water, or of an actual sinking of the level of the sea, must be mentioned. It cannot be doubted, that, during the former elevated temperature of the surface of the earth; during the existence of the power of engulphing water, which must have been the consequence of the occurrence of a larger amount of open fissures; and during the continuance of an entirely different constitution of the atmosphere; great changes must at one time have taken place in the level of the sea,—changes which were dependent on the increase or diminution of the liquid on the earth. In the present state of our planet, however, there has hitherto been an entire absence of direct proofs of a real continued diminution or increase of the sea; and there is also an absence of evidence of gradual changes in the *mean* height of the barometer, at the level of the sea, at the same points of observation. According to the observations of Daussy and Antonio Nobile, an increase of the height of the barometer would of itself produce a lowering of the level of the water. As, however, the mean pressure of the atmosphere at the level of the ocean is not the same in all latitudes, owing to meteorological causes arising from the direction of the wind and from moisture, the barometer alone would not afford sure evidence of an alteration of the level of the sea. The important observations, according to which some sea ports in the Mediterranean were, at the beginning of this century repeatedly laid dry for periods of many hours, seem to prove that a *local* retirement of the sea, and a permanent drying up of a small portion of the coast, *can* be produced by a change in the direction and strength of currents of the sea, without an actual diminution of water, and without a general depression of the whole ocean. We must be very careful in our interpretation of the information which has recently been obtained respecting these complicated phenomena; for it is easy to ascribe to water, one of the "ancient elements," what belongs to two others, viz., earth and air.

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* As to the sinking and rising of the bottom of the South Sea, and the various areas of alternate movements, *vide* Darwin's Journal, pp. 557 and 561–566.

In the same manner as the configuration of continents, which we have hitherto been delineating in its *horizontal* extension, exercises, by means of the *varied form of its outline*, (*äussere Gliederung*,) i.e., by the indentations and projections of its coasts, a beneficial influence on climate, commerce, and the progress of cultivation; so there is also a kind of *internal division of parts*, by means of perpendicular elevation of the surface, (mountain chains and table-lands,) which has produced not less important results.

Every thing which has produced alternation of forms and *variety of physiognomy* (*Polymorphy*) on the surface of our planet (in addition to mountain chains, we here refer also to great lakes, grassy steppes, and even to deserts surrounded by woody regions which may be compared to coasts), impresses a peculiar character on the social condition of the population. Elevated tracts of country, covered by snow, prevent intercourse; but a mixture of lower *detached mountain masses** and low lands, as we see exemplified in so favourable a manner in the south of Europe, multiplies meteorological processes, as well as the productions of the vegetable kingdom; and, as different degrees of cultivation then belong to each tract of country, even in the same latitude, necessities are created, in order to satisfy which, the activity of the inhabitants is stimulated. Thus, the dreadful convulsions, which, in consequence of the action of the *interior* on the exterior, have caused the rising up of vast mountain chains, by means of the sudden elevation of a portion of the oxidised crust of the earth, have, after the restoration of tranquillity, and the resuscitation of slumbering organisms, imparted to the solid land of both hemispheres a rich variety of individual forms, and removed, in a great measure, the barren uniformity which operates, with an impoverishing effect, on the physical and intellectual powers of the human race.

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* Humboldt, *Rel. Hist.*, t. iii. p. 233-234. Compare also the acute observations on the configuration and position of mountain chains, in Albrecht von Roon's *Grundzügen der Erd-Völker-und-Staatenkunde*, vol. i., 1837, pp. 158, 270, and 276.

To each system* of these mountain chains, a relative age has been assigned by the splendid views of Elie de Beaumont, who has shewn that the elevation of a mountain chain must necessarily have taken place between the period of deposition of the inclined strata, and that of the deposition of the horizontal strata extending to the foot of the mountains. The *foldings* of the crust of the earth (elevations of the strata), which are of the same geognostical age, appear also to have one and the same direction. The line of strike of the elevated strata is not always parallel to the axis of the chains, but sometimes cuts across it; so that, according to my opinion,† the phenomenon of the inclination of the beds, which is found repeated in the neighbouring plain itself, must be more ancient than the elevation of the chain. The principal direction of the whole solid land of Europe (SW. to NE.) is the opposite of that of the great terrestrial fissures, (NW. to SE.,) which extend from the mouths of the Rhine and the Elbe, through the Adriatic and Red Seas, and also through the system of mountains of the Puschti-Koh in Luristan, to the Persian Gulf and the Indian Ocean. Such a crossing of geodesical lines at nearly right angles, has exercised a vast influence on the commercial relations of Europe with Asia and North-Western Africa; and also on the progress of civilization on the formerly more prosperous shores of the Mediterranean Sea.*

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* Leopold von Buch, *Ueber die Geognostischen Systeme von Deutschland*, in his Geognostical Letters to Alexander von Humboldt, 1824, pp. 265-271; and Elie de Beaumont, *Récherches sur les Revolutions de la Surface du Globe*, 1829, pp. 297-307.

† Humboldt, *Asie Centrale*, t. i. p. 277-283. See also my *Essai sur le Gisement des Roches*, 1822, p. 57; and *Relat. Hist.*, t. iii. pp. 244-250.

Since immense and lofty chains of mountains occupy our imaginations, by presenting themselves as evidences of vast terrestrial revolutions, as the boundaries of climates, as great water-sheds, or as the bearers of different vegetable worlds; it becomes so much the more necessary to shew, by a correct numerical estimate of their volume, how small the whole quantity of the elevated masses is in comparison with the area of entire countries. The mass of the Pyrenees, for example—a chain, the mean height of whose summits, and the superficial extent of whose base, are known by accurate measurements—would, if distributed over the area of France, increase the height of that country only 115 English feet. The mass of the eastern and western chains of the Alps would, in the same manner, raise the height of the flat country of Europe by only 21·3 English feet. By means of a laborious investigation,† which, from its very nature, only gives the upper limit, *i. e.*, a number which may be smaller, but cannot be larger, I have ascertained that the centre of gravity of the volume of the land which rises above the present level of the sea, is situated at a height of 671 and 748 English feet in Europe and North America, and 1131·8 and 1151 English feet in Asia and South America. These calculations indicate the lowness of the northern regions: the great steppes of the plains of Siberia are counter-balanced by the enormous swelling of the surface of Asia between lat. 28½° and 40°, between the Himalaya, the northern Thibetian Kuen-Lun, and the Sky Mountains. We can, to a certain extent, determine, from the estimated amounts, where the plutonic force of the interior of the globe has operated with greatest power in elevating continental masses.

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* *Asie Centrale,* t. i., pp. 284-286. The Adriatic Sea has also a SE,-NW. direction.

† *De la Hauteur Moyenne des Continents* in *Asie Centrale,* t. i., pp. 82-90 and 165-189. The results which I obtained are to be regarded as *nombres-limites.* Laplace estimated the mean height of continents at 3280 English feet, which was at least three times too high. That immortal geometrician (*Mécanique Céleste,* t. v., p. 14) was led to this conclusion by hypotheses regarding the mean depth of the sea. I have shewn (*Asie Centrale,* t. i., p. 93) that the Alexandrine mathematicians, according to the testimony of Plutarch (*in Æmilio Paulo,* cap. 15.), believed that the depth of the sea was dependent on the height of the mountains. The height of the centre of gravity of the volume of the continental masses has probably been subjected to small changes in the course of thousands of years.

There is nothing to assure us, that the same plutonic forces may not, in the course of future ages, make additions to the systems of mountains of different degrees of antiquity, and having different directions, as they are enumerated by Elie de Beaumont. Why should the crust of the earth have already lost the property of becoming elevated or folded? The mountain-systems of the Alps and of the Andes, which were almost the last that made their appearance, have elevated colossal masses in Mont Blanc and Monte Rosa, in Sorata, Illimani, and Chimborazo, masses which do not at all lead to the conclusion that there had been a diminution in the intensity of subterranean power. All the phenomena of geognosy indicate a periodical alternation of activity and tranquillity.* The repose which we now enjoy is only apparent. Earthquakes, which agitate the surface of the earth in every region under heaven, and in every kind of rock,—the rising of Sweden,—and the production of new volcanic islands,—do not give evidence in favour of a continuance of the tranquillity of the earth.†

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* *Vide* the Second Geological Letter from Elie de Beaumont to Alexander von Humboldt, in *Poggendorff's Annalen*, vol. xxv., pp. 1-58.

† From *Kosmos. Entwurf einer Physischen Weltbeschreibung von Alexander von Humboldt*, vol. i., p. 301. 1845.

On the Origin of Quartz and Metalliferous Veins. By Professor Gustav Bischof, of Bonn.

(Continued from vol. xxxviii., p. 353.)

It is a quite common occurrence to find the rock adjacent to quartz veins more or less impregnated with quartz, or, at all events, altered. v. Œynhausen and v. Dechen,* who had an opportunity of observing a great number of quartz veins or strings in the granite or killas of Cornwall, in exposed cliffs on the sea-side, always found the adjacent rock changed. Near Mousehole, this alteration extended for an inch and a half into the granite, giving it a darker yellowish-grey colour, and a harder and quartzy appearance. The quartz strings are about an eighth of an inch thick, widening at some parts to nearly six inches. Near Cligga Point they found a rock very similar to granite, of a light grey colour, having, as its prevailing constituent, quartz crystallized, generally very distinctly, in double six-sided pyramids; mica and felspar, however, only in small quantities, and more frequently schorl. This rock is weathered on the surface, but is harder underneath, and, at a little distance from this spot, makes a transition into the granite. Here, too, the felspar appears more frequently, partly fresh, partly decomposed into porcelain earth, and the quartz is less apparent. The quartzose rock has the same relation to granite, as the granite altered by the quartz veins at Mousehole has to the granite there, and this latter rock is actually traversed by frequent quartz strings, which seem to have produced a like alteration. At another place near Cligga Point, there is a perpendicular granite cliff, above 100 feet high, traversed by numberless quartz veins, altering it on both sides. At a third point, the granite presents a most remarkable appearance. It is traversed by numberless quartz veins, which have changed it, on either side, into a rock similar to that already described (much quartz, with little mica and felspar, but frequent schorl). These quartz strings are seldom more than a quarter of an inch thick, and have a great dip northwards, whereby the granite appears perfectly stratified, subdivided into layers of from two to three feet in thickness. The unaltered granite is quite similar to that at the point just mentioned, and very liable to weather. In the vicinity of the quartz veins it does not weather. This arises, no doubt, from the impregnating quartz having stopped the pores, so that no water could penetrate afterwards to cause decomposition.

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* Karsten's Archiv, 1828, vol. xvii., p. 3.

Such quartz veins, of an eighth to a quarter of an inch wide, forbid the most distant thought of formation by heat. v. Dechen and v. Œynhausen also found in a quartz vein of a foot in width, near Mousehole, masses of a greenstone-like killas, of a foot long, as far as the vein traversed this formation. These masses of adjacent rock could not have existed in so great a mass of quartz, if it had come in contact with them in a state of fusion. It is as little to be thought of that the quartz, when it impregnated the granite of the adjacent rock, was molten; for, on the one hand, it is inconceivable how a substance which, like quartz, is much less fusible than granite, could impregnate it; and, on the other hand, if we did assume that the quartz and granite were fused together, a granitic mass must have resulted again after the gradual cooling, without the felspar and mica diminishing in any considerable degree. In this latter case, the thin quartz strings of the veins would naturally have run together with the granite; and, after gradual cooling, there would have been found in them the same substance as in the adjacent rock, and there would not have crystallized from it pure quartz.

If, on the other hand, we assume that the quartz entered the vein fissures in a watery solution, all appearances may be very naturally explained. In the first place, the penetration of a watery solution into so compact a rock as granite, is much more easy to conceive than that of a molten, however liquid, mass. The watery fluid always maintains its liquidity, and if it remain for a lengthened period in contact with a rock, however little porous, it will gradually penetrate far into it, in consequence of its capillarity. A molten fluid, on the other hand, loses its liquidity as it gradually cools, and, by its heat expanding the rock, contracts the pores, and so itself bars the passage. If besides this, as in the case in question, the molten fluid is hotter than the fusing heat of the rock into which it endeavours to penetrate, and if it have chemical affinity for its components, the consequence could not be an impregnation but a fusion together. In the second place, a watery solution, while it deposits matter in a rock, can dissolve others and carry them off; and if the contact with it continues very long, the exchange may be so considerable, that great masses of the constituents may disappear, and just as great masses take their places from the watery solution. Such circumstances cannot be conceived as to the penetration of molten substances: an exchange is impossible in this case. A molten substance can only fill the pores of a rock, or only enter in the proportion of these intervals. The expansion of the stone, by contact with so heated a substance, may, however, easily amount to more than the volume of these pores, in which case the rock can only take up so much as fuses on the surface of contact.

In the granite altered by the quartz veins in the above-named places, the felspar and mica are much diminished. What, therefore, is more probable than that the watery solution of quartz, which penetrated into the granite, gradually decomposed and carried away these substances, precipitating instead its silicic acid?

Thus the double six-sided pyramidal crystals of quartz, spoken of by v. Dechen and v. Œynhausen, may have been, not the original quartz of the rock, but only that formed from the watery solution. Where they observed the more frequent occurrence of felspar, partly undecomposed, partly weathered to porcelain-earth, the quartz was less prevalent. In this instance, only the first stage of the decomposition of the felspar is manifested; but, in the entirely converted rock, the porcelain earth had also been carried away, quartz having taken its place. It is clear that such considerable changes in a rock, by watery solutions, must have required a very long period, especially as, in the case in question, the mica, so difficult of decomposition, had diminished with the felspar. But we can never be at a loss in the assumption of a period of time, however long, if we can only indicate a process, however slow in its action, from which compositions and decompositions result. The impregnation of the adjacent rock with silica, presents itself not only in quartz veins, but also in many others peculiar to certain vein formations. This impregnation, it is well known, goes sometimes so far, that the characteristic colour and original texture of the adjacent rock disappear, and it makes a transition into hornstone. V. Weissenbach* cites several instances of this kind. Thus this phenomenon pervades, quite remarkably and generally, the tin vein formation of Altenberg. I shall take another opportunity of treating of how this impregnation, passing into the thinnest strings, appears to have a *causal connection* with the introduction of the tin ore itself. Near many of the veins of the Schneeberg district, the clay-slate is richer in silica than elsewhere. In and near several of the veins of the Freiberg district, the gneiss and mica slate appear so much impregnated with silica, that the original striated structure can scarcely be observed; the micaceous particles are dull and clayey, the felspar has disappeared, and there presents itself, at last, a hornstone, passing quite into the quartz, in which the original gneiss is scarcely recognisable.

The same appearances present themselves here in gneiss, therefore, as in Cornwall in granite: here, as there, the quartz predominates, as felspar and mica disappear. We may, therefore, assert pretty generally, that when watery solutions of silica circulate among rocks containing felspar and mica, or any alkaline silicates, the former is precipitated; the latter dissolved and carried off. And so, in veins in clay-slate, the walls of which are silicified, it may have been alkaline silicates, micaceous particles, &c. &c., which effected the exchange. We thus find in veins the same relative circumstances as I have mentioned in reference to mineral springs, only with this difference, that the acid water changed the trap into clay, by decomposition of its alkaline silicates, and, instead of depositing silica, deposited carbonate of the protoxide of iron. Whether, however, the deposit of silica in veins resulted from abstraction of carbonic acid, as in the deposit of sphærosiderite, is doubtful, as carbonic acid is not the solvent of silica in water; for when the carbonic acid is expelled from mineral waters, the silica is not precipitated.

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* *Abbildungen merkwürdiger Gangverhältnisse aus dem Sächsischen Erzgebirge;* Leipzig, 1836, p. 31.

Everything concurs to justify the assumption, that the adjacent rock of veins has had a material influence on the deposition of the substances from the fluids which had formerly flowed in them, and that it has thereby undergone many changes; here silicification, there weathering—here, again, discoloration, there colouring, &c. &c. If it can be proved, that not only the non-metallic veins, but also the ores, have been introduced into the vein-clefts in the wet way, as I shall endeavour to shew elsewhere, then we may presume that the nature of the adjacent rock has had an influence not only on the former, but also on the latter.

In this manner, too, may be explained the so frequent occurrence, that metalliferous veins, running through different geological formations, change their nature; in one becoming richer, in another impoverished. The Erzgebirge presents many examples in this respect. Thus, the veins of the Halsbrücke formation occur in gneiss, less frequently in mica-slate, &c. When they reach the clay-slate, they are scattered, or clean cut off. It is exactly the same in the veins of the Bräunsdorf formation; they occur in mica-slate and gneiss, and lose themselves in clay-slate. The veins of the Zschopau formation present themselves chiefly in mica-slate and clay-slate;[*] and here they become impoverished in the latter. On the other hand, there are examples of the vein stuff of some veins appearing independent of the adjacent rock. Thus the veins of the Schneeberg formation occur principally in clay-slate, generally, however, in mica-slate. They run out of the clay-slate UNALTERED IN THE ORE they bear into the granite.[†]

It is very easy to conceive, that now this, now that substance would be deposited from the same watery solution, according as it came in contact with this or that rock. Were they, for example, felspar and mica, which induced, by exchange, the deposit of silica or any other substance, such a deposit could only take place when the solution flowed through fissures of a crystalline rock, containing these minerals. Should the veins run into other rocks, in which these minerals were wanting, there could no deposit of such substances take place.

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[*] Freiesleben, pp. 20, 34, 36.

[†] Ib., p. 39.

We must not overlook the essential circumstance, that the weakest affinities would come into play in processes which, like those by which the vein-stuffs were introduced into the fissures, went on with such extreme slowness. Several instances, in the circle of chemical phenomena, indicate this. Thus I found in a wooden tub, bound with iron hoops, in a manufactory of sulphate of copper (green copperas), deposits of solid metallic copper, of which some had a weight of several pounds. They fixed themselves on two staves, between which a plate of copper had forced itself. It was manifestly the iron hoop which had, in this case, effected the reduction of the copper. It was not, however, a simple precipitation of the copper by iron, but, as in the so-called metallic vegetations, a galvanic or electric effect; as, namely, a thin metallic plate of copper had been deposited in the interval between the two staves by simple chemical action, a metallic contact was established between the copper and the iron of the hoop, and now the precipitation of copper on copper, which formed the negative pole, went slowly forwards, without the iron further influencing the process directly. Had the effect resulted entirely from the iron hoop, it must have been perfectly eaten through in this part, which was not the case. If we consider that, in this process, through the interstice of two staves, which was so narrow that no fluid could run out, a chemical action nevertheless took place, which, in the lapse of some years, effected the deposit of considerable masses of metallic copper, it cannot surprise us to observe similar appearances in metalliferous veins. We can compare the effect of the iron hoop with that of substances which had been contained in the adjacent rock, and which communicated with the fluid circulating in the vein-fissure through as narrow an interstice as between two staves. As in the example adduced, copper was deposited at first by a chemical process, and afterwards by an effect of contact, so, in like manner, substances might be deposited from fluids circulating in vein-fissures. Though no such energetic chemical affinities occurred in the latter, as between the iron and the sulphate of copper, time might compensate for deficiency in energy of affinity.

The impregnation of the adjacent rock with ores belongs exactly to this category. This impregnation of the walls, as well as of fragments in the vein, is generally strongest where the adjacent rock is at the same time very much decomposed, or interpenetrated by extraneous matter. The minutest impregnation with tin-ore runs through most tin-vein formations, chiefly so far as the adjacent rock is silicified at the same time; and there are tin "courses" (*züge*) whose "strings" have scarcely any tin-bearing vein-stuffs,—merely barren clefts, which are worked solely for the sake of the *impregnated adjacent rock.* Alongside many veins of the Freyberg lead-formation, blende and galena appear here and there to form the striated component of the gneiss, in place of felspar and mica. Yet much more frequent in the Freyberg lead-veins is the impregnation of the gneiss in and adjacent to them with arsenical and iron pyrites. The adjacent rock has also been worked here and there, on account of its impregnation with the richer silver ores. The impregnation does not always correspond exactly with the ore-produce of the vein in the same place. Thus there presents itself, in a certain vein, only quartz, with parcels of iron-pyrites and galena; whilst the adjacent rock, so far as disclosed, is strongly interpenetrated by large granules of black blende. Imprégnation with arsenical pyrites is often met with near Freyberg galena veins, at points where they carry very little or no arsenical pyrites, &c.

All these appearances have this in common, that the adjacent rock is much decomposed, or interpenetrated by extraneous ingredients in the locality of the impregnation. Both indicate an exchange between the components of the adjacent rock and those of the fluid which had circulated. In the latter case, the ores seem to have found their way simultaneously with the extraneous matters. The difference between the impregnations of the adjacent rock and the ore-courses of the veins, may be explained, too, in that, in the vein, a cause was at work which could only precipitate *certain ores*, whilst others remained in solution, and only came to be separated by longer contact with the components of the rock, and by the power of elective affinity. However, the watery solution may also have changed its nature in the course of time. Nothing more strongly bespeaks the mutual exchange than the above-mentioned substitution for felspar or mica of blende and galena.

In the same manner, we may conceive how, frequently at the crossing of two veins of different formations, a group of metallic minerals is found heaped together, which is not peculiar, as there grouped together, to either of the two veins individually. Thus, for example, there are frequently found native silver, with sulphuret and antimonious sulphuret of silver (silver-glance and red silver-ore), brittle silver-glance, and earthy silver-glance, at the crossing of veins of the Züg and Halsbrücke formations, or at crossings of veins of the Sauberg silver formation with the Ehrenfriedersdorf tin formation; or tin-ore is found in the silver veins of the Annaberg formation, in fissures that branch to them.

(*To be concluded in next Number.*)

Remarks on the Trade-Winds and other Currents in the Atmosphere at Barbadoes; with an attempt to develop the Causes of Hurricanes in the West Indies. By ROBERT LAWSON, Esq., Assistant-Surgeon H.M. 47th Regiment. Communicated by the Royal Scottish Society of Arts.*

I. *On the Trade-Winds.*

1. The researches which have been made on the nature of the great storms in the West Indies, and of the Indian and

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* Abstract of a Paper read before the Society on 10th and 24th February 1845.

Chinese seas, while they have disclosed many highly important phenomena, have, nevertheless, failed to afford an account of the peculiar circumstances which concur to produce them. These storms in the West Indies, at least, commence about the equatorial margin of the trade-winds; a fact which gives a peculiar interest to the investigation of the atmospheric currents found to exist there. Having been stationed for nearly a year in Barbadoes, an island that has suffered more, perhaps, than any other in the West Indies, from hurricanes, and which was admirably situated for the purpose, I paid a good deal of attention to this subject, and have elicited some facts, which, so far as I am aware, have not hitherto been noticed.

2. The trade-winds are usually ascribed to the greater heating power of the sun's rays in the immediate vicinity of the equator than elsewhere, expanding the air in contact with the earth's surface, and, by thus rendering it specifically lighter, causing it to ascend, while colder air flows in from either side to supply its place; but, as these currents pass to points of the surface where its velocity of rotation is greater than at those which they originally left, and as the air composing them is some time in acquiring this increased velocity, they assume an easterly direction, instead of coming from the true north and south, as they would have done had the earth been at rest. The ascent of the air at the equatorial limit of the trade is greatly facilitated, especially during the colder months, in the corresponding hemisphere, by the great addition to its aqueous vapour acquired during its passage.

3. The trade-winds are materially influenced in the vicinity of the West India islands by the configuration of the neighbouring coast of South America. This extends from the island of Trinidad, in latitude 10° N., and longitude 60° W.,—on the one hand, in a south-easterly direction, for about 600 leagues, and on the other, from the same point nearly west. From November to March, the sun being in the southern hemisphere, the South American continent becomes considerably warmer than the neighbouring sea, and the NE. trade is felt strongly over the northern half of the former division of the coast, and over the whole of the latter; but, as the sun ac-

quires a northern declination, the temperature of the sea increasing, the equatorial limit of the NE. trade is gradually removed to the north, leaving the coast to the south-east of Trinidad almost entirely from April or May to October, and becoming weaker and more irregular on that to the westward of and around it.

4. The equatorial limit of the NE. trade is found to vary considerably in the open sea in the different months of the year, while that of the SE. trade alters much less. The following table, taken from a more extended one in Horsburgh's East India Navigator, gives the mean position of the equatorial limits of the trades between longitude 18° and 26° W., every second month of the year:—

Month.	Mean Equatorial Limits of NE. Trade.	SE. Trade.	Distance between Mean Limits.
February,	6N.	1¼°N.	4¾°
April,	5¾	1¼	4½
June,	9	3	6
August,	13	3¼	9¾
October,	10	3	7
December,	5½	3¼	2¼

The individual results for each month seem to have varied from the corresponding mean about 2° each way, an explanation of which will be attempted hereafter.

5. The temperature of the sea, on either side of the equator, alters very considerably with the sun's changes in declination. This is well shewn by the following observations made on board the French frigate L'Hermione, in a voyage to and from Rio Janeiro in 1816. The frigate crossed the line on the 16th May outward, and again on the 11th October, homeward-bound, and in both cases near the meridians laid down for the above table. The temperatures of the surface of the sea were, on

	Lat. North.		Long. West.		Temp. of Sea.	
	°	′	°	′	°	
May 2.	22	7	24	15	68.0	Outer Limit of NE. Trade.
October 27.	22	32	31	13	73.9	
May 10.	4	43	28	33	79.2	Inner Limit of NE. Trade.
October 18.	9	57	22	49	84.4	
May 14.	2	36	27	3	78.6	Inner Limit of SE. Trade.
October 12.	3	1	23	35	80.4	
May 24.	20	3	44	14	77.0	Outer Limit of SE. Trade.*
October 2.	20	31	33	11	73.2	

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* Annales de Chimie, &c., tom. iv., pp. 414-17.

The observations in May were made from 7 to 8 P.M.; those in October from noon to 1 P.M. On this account, the temperatures during the former will be, strictly speaking, lower than they should be, in order to compare them with those during the latter; but the correction necessary to reduce them to that of mid-day is so small, that it may be disregarded. Considerable and abrupt variations occur in the temperature of the sea near the line, about 20° W. longitude, which are undoubtedly occasioned by the currents which meet in that neighbourhood; for on each side of this locality, as far as the tropics, the temperature diminishes with tolerable regularity. By the above table, the surface of the sea through the whole course of the NE. trade, seems to have increased in temperature between May and October by upwards of 5° Fahrenheit, while that in the course of the SE. trade was diminished in the same time by about 4° Fahrenheit. The positions of the equatorial limits of the trades correspond very accurately with those in Horsburgh's table.

6. The temperature of the sea near Barbadoes, according to some observations of my own made on my passage out in March 1841, was as below. These observations were made at noon; they have been corrected for the errors of the thermometer, and may be depended on to about 0.1° Fahrenheit.

	Lat. North.		Long. West.		Temp. of Sea.
	°	′	°	′	°
March 26.	13	44	44	17	76.1
... 27.	13	16	47	46	76.8
... 28.	12	59	50	49	77.3
... 29.	12	46	53	53	77.7
... 30.	13	11	56	45	78.1
... 31.	13	1	59	10	79.1
During April, while lying in Carlisle Bay, Barbadoes, mean of 5,					79.3

The sudden increase of the temperature of the sea water on the 31st, and which remained pretty constant at Barbadoes during the month of April, was caused by the equatorial current, which, being directed to the NW. by the coast of South America, flows past Barbadoes, its northern margin being considerably to the north-east of the island.

7. The temperature of this current increases considerably

towards the end of summer, and that of the sea to the northward still more, as shewn by the following observations made by Mr Battersby, 47th Regiment, in the beginning of September 1841. A similar series, made by myself in February 1842, is subjoined, which will afford a very good idea of the effect of season on the temperature of the sea in this neighbourhood. The observations have been corrected for the errors of the corresponding instruments.

	Lat. about	Long.	Temp. sea.
Sept. 2d,	15° 0′ N.	No obs.	81°.7 Fah.
... 3d,	17 20 ...	...	81 .7 ...
Feb. 12th,	17 41 ...	60° 18′ W.	76 .8 ...
Sept. 4th,	20 18 ...	No Obs.	80 .7 ...
Feb. 13th,	20 5 ...	61° 14′ W.	76 .8 ...
Sept. 5th,	22 16 ...	No Obs.	82 .7 ...
Feb. 14th,	22 25 ...	61° 26′ W.	76 .1 ...
Sept. 6th,	23 44 ...	64° 12′ ...	82 .7 ...
Feb. 15th,	23 53 ...	61° 1′ ...	74 .5 ...

In several instances, in this table, the longitude is not given; but, as the ship's track lay to the eastward of the Caribbean Islands, no material error will arise from the omission. In September, the outer limit of the NE. trade, in 64° W. long., was not well defined; in February, in long. 60° W., it was about lat. 26° N.

8. The diurnal variation of the temperature of the air over the sea, within the tropics, is very small, and the mean temperature is rather under that of the surface of the sea at the place,[*] a fact borne out by most observations I have met with. It may therefore be concluded, that the air, in passing through the region of the trades, has its temperature increased to the same extent as the sea, while the dew-point is at the same time considerably raised.

9. On my arrival in the West Indies, I commenced to observe the courses of the different strata of clouds, as recommended in the Report of the Committee of Physics and Meteorology of the Royal Society, for the purpose of determining the existence of crossing currents at different heights in the atmosphere. These were at first made with very little regularity or method; but, from the beginning of September, I be-

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[*] Pouillet, Elemens de Physique, tom. ii., p. 519.

stowed considerably more care on the subject, generally examining the state of the clouds at 9 A.M. and 3 P.M., and again at 9 P.M., when there was sufficient light to admit of a satisfactory conclusion being formed.

10. By the above means, three currents were generally found to exist in the atmosphere at Barbadoes, and occasionally a fourth. These were,—1*st*, The regular trade wind below; 2*d*, The equatorial or returning current above; 3*d*, A middle current, from ESE. or SE. to SSE. and S.; and, 4*th*, A current which seemed to be placed higher in the atmosphere than the last, though below the equatorial one, and which came from NW. to NNW. or N.

11. The trade is the usual wind at Barbadoes; it commonly blows from the ENE. or E., though, in this respect, it differs a good deal. The following table, in which all the recorded observations on its direction at 9 A.M., 3 P.M., and 9 P.M., are arranged, so as to shew the effect of season, will indicate this more plainly:—

Table, shewing the number of times the wind blew from each point of the compass at 9 A.M., 3 P.M., *and* 9 P.M., *at Barbadoes, during each month, from May* 1841 *to January* 1842 *(bearings true.)*

Direction.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	TOTAL.
NNW. & NW.,	...	...	...	3	...	...	...	...	...	3
N.,	...	...	...	1	1	...	...	...	...	2
NNE.,	...	...	1	2	1	1	1	...	1	7
NE.,	...	...	...	7	6	2	1	6	9	31
ENE.,	1	15	40	21	29	39	51	71	47	314
E.,	16	34	41	28	8	13	9	2	13	159
ESE.,	16	28	3	15	4	19	6	1	2	94
SE.,	9	4	2	7	19	8	7	2	...	58
SSE.,	5	1	2	3	2	2	...	...	...	15
S.,	...	...	...	...	1	...	...	...	...	1
SSW. & WSW.,	...	...	...	...	2	...	...	...	...	2
	47	82	89	82	73	84	75	82	72	686

A glance at the totals in the last column will shew, that, on the whole period, the winds from E. to NE. were by far the most prevalent; but this does not apply to the months taken singly.

12. It has been stated above, that the temperature of the sea at noon, at Barbadoes, in April, was 79°.3 Fahr. (6); and, that in September, that of the current which sets past the island was 81°.7 (7). No error of any consequence will be committed, if the mean of these 80°.5 be assumed as its temperature round Barbadoes during May and June. I have elsewhere shown, that the mean temperatures of the air in the latter part of May and June 1841, there, were 79°.77 and 80°.49 Fahr., and the mean maxima 83°.86 and 85°.23 respectively;* the former almost equal to the temperature of the sea in the vicinity at noon, the latter exceeding it, and, consequently, that of the superincumbent air (8). This unequal distribution of temperature in the air, caused its ascent over the land during the day, while the cooler air flowed in from the sea to supply its place, at the same time that the regular trade-wind continued at a moderate elevation, as shewn by the drift of the lower clouds. These observations having been made at the south-west part of the island, the wind naturally drew to the south-ward during the day (it was frequently from ESE., while the lower cumular clouds were drifting from E. or ENE.); and on one occasion, while it had been the greater part of the day at SSE., the lower cumuli were drifting with considerable rapidity from E. I do not mean, however, to state, that all the north-easterly winds during May and June were of the kind just described, for, in a good many instances, the lower clouds moved in the same direction as the wind.

13. In July, the mean temperature had fallen to 80°.05 Fahr., and the mean maximum to 84°.72,† while the temperature of the sea must have increased. The excess of temperature in

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* Edinburgh New Philosophical Journal, June 1843.

† As maximum and minimum thermometers give the extremes of temperature during a day, without reference to the hour at which these occur, their indications for a month must always be, the former higher, and the latter lower, than the corresponding points in the mean diurnal curve of temperature, and these differences will be greater as the weather during the period was more unsettled. The weather at Barbadoes, in July, was particularly unsettled; frequent heavy showers, accompanied by sharp squalls, occurring during the day, which always caused a considerable reduction of temperature. It is not a little remarkable,

the air over the land was thus less. This was still farther reduced by the occurrence of frequent heavy showers, which never failed to cause a considerable fall of the thermometer, and must have prevented the air, at a very slight elevation, from acquiring that increase of temperature, by the regular interchange of the lower and warmer strata with those above in passing over the land, which, under ordinary circumstances, would have taken place. The tendency of the air over the land to ascend during the day was thus, in a great measure, done away with; and it is obvious, by the numbers in the table, that the trade-wind assumed its normal course, and the sea breeze disappeared.

14. In August, September, and October, which are called the hurricane months, the winds from the southward of E. again became prevalent, and they affected the atmosphere to a considerable height, being then, for the most part, accompanied by a movement of the lower clouds in the same direction. Instances undoubtedly presented themselves, in which the direction of the wind differed two or more points from that from which the clouds were moving, but these were not frequent. The mean temperatures at Barbadoes were 80°.63 Fahrenheit, 79°.58, and 79°.72; and the mean maxima, 85°.63, 84°.09, and 84°.77, respectively. The temperature of the sea at noon in the beginning of September was 81°.7, and a little to the northward 82°.7; temperatures considerably exceeding the mean temperature of the atmosphere over the island, whereby the tendency to the occurrence of a sea breeze was much diminished. The temperature of the sea, too, being higher towards the outer limit of the trade-wind than at its equatorial one, by increasing that of the superincumbent air (8), and rendering it nearly the same over a large expanse of sea, almost neutralized, as it were, the cause of the trade-winds, but left the atmosphere at a higher temperature, and containing a large quantity of aqueous vapour, liable to be acted on by any disturbing cause. The gradual diminution of the

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that the lowest temperature which occurred during my stay in Barbadoes, viz. 69°.8 Fahr., was on the afternoon of the 27th June, during an unusually heavy fall of rain.

temperature of the sea in November, December, and January, and the increase of that of the continent of South America, restored the trade in all its former force, and, during these months, the south-easterly winds almost disappeared.

15. The winds in the West Indies were much affected by the moon's declination and her time of transit. The chief cause of the trade-winds is undoubtedly the higher temperature communicated by the sun's rays to the atmosphere in the neighbourhood of the equator than in the extratropical latitudes; and, while the difference is sufficiently great, a brisk trade prevails, and the effect of the attraction of the sun and moon is not very obvious; but when, during summer, the sea and superincumbent atmosphere in the vicinity of the tropics become much warmer, and the strength of the trade is much abated, this becomes apparent, and to it all the greater deviations of these winds from their regular course seem attributable. I am not aware that the direct dependence of the winds in intertropical latitudes, or the attraction of the sun and moon on the atmosphere, has ever been made out, or, indeed, scarcely hinted at. My attention was first directed to the subject in June 1841, by observing the anomalous directions of the wind during that month, which seemed quite at variance with the usually received opinion as to the cause of the trade-winds.

16. The observations of Flaugerques at Viviers, shew a decided alteration in the height of the barometer under the different phases of the moon, and also under the perigee and apogee. Mr Howard's observations in this country exactly correspond with those of Flaugerques. Some months after my return to England in 1842, I became aware of the researches of Mr Howard and Mr Lubbock on the influence of the moon's declination on the height of the barometer.* I have since seen the notice of the paper of Lieutenant Lefroy, R.A., on the influence of the moon on the height of the barometer at St Helena.† In this it is stated, "that the moon's passage over both the inferior and superior meridian produces a slight increase of pressure; a maximum in the curve occur-

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* Lond. Edin. and Dub. Phil. Mag., vol. xviii., pp. 552-5.

† Id., vol. xxi., p. 227.

ring at both (that of the latter being slightly greater), while the minima correspond to the moon's rising and setting." It is likewise stated, that "the pressure is greater about the period of new moon, and greater in the third and fourth than in the first and second quarters." Lieutenant Lefroy also found the pressures under the perigee to be greater than under the apogee.

17. These remarks of Lieutenant Lefroy on the moon's influence on the atmosphere at St Helena, are in perfect accordance with the phenomena presented by the winds at Barbadoes. These two islands are in nearly the same latitudes in the southern and northern hemispheres, though there is this difference between them, viz., that St Helena is near the centre of the SE. trade, while the equatorial limit of the NE. trade is frequently to the north of Barbadoes in the summer months, a fact of the highest importance in reference to the winds and storms of these latitudes.

18. Were the sun or moon to move constantly on the equator, its attraction, when near the meridian, would increase the rapidity of the trade-wind, while it retarded that of the returning or equatorial current, and the result would be an accumulation of air, producing a slight rise in the barometer. A similar result would occur on the inferior meridian, and also on the upper when it passed the inferior meridian; and these, in both cases, would gradually disappear as the sun or moon approached the intermediate positions. If the sun and moon both be considered to move on the equator, the sum of their effects on the atmosphere would differ, according to their angular distance being greatest at the conjunction and opposition, and least at the quadratures, the maxima and minima running gradually into each other between those points. If, now, the question of declination be introduced, the points to which the sun or moon would tend to accumulate the atmosphere would no longer be the equator, but would deviate on either side of it, their latitude being the same in amount, and of the same name as the declination of the body at the upper meridian; and of the same amount, but opposite in name, to the declination on the lower. In the case of both sun and moon, the sum of their effects would still be greatest at the

periods of conjunction and opposition, and would vary between these according to their differences in declination and angular distance. But at all times, the effect of the sun's attraction being less than that of the moon, and being complicated with his calorific influence on the superior meridian at least, will be more obscure, and will contribute less to the modification of the winds. The influence of the moon, likewise, will be greater in perigee than in apogee.

19. The effect will differ considerably, according as the point at which the accumulation takes place is situated, between the equatorial limits of the trades, or within the trades themselves. In the former case, especially about the time of new and full moon, the trade will be at first accelerated, and the equatorial current retarded, on her passing both the upper and lower meridians, which is in accordance with the observations of Mr Lefroy, noticed above (16); but, on the accumulation of air between these limits becoming considerable, its gravity will not only prevent any farther inflowing, but, when assisted by the solar heat acting on the land and sea on either side, actually cause a returning current from its outer margin towards the poles. In the latter, supposing the moon's declination to be 20° N. for instance, her attraction would retard the NE. trade-wind to the southward of that latitude, and accelerate it to the northward of it; and it would accelerate the equatorial current to the southward, and retard it to the northward, while it accelerated the SE. trade throughout, and equally retarded the equatorial current on that side of the equator. A similar arrangement would occur on the inferior meridian, only it would be reversed, the NE. trade being there affected as the SE. had been on the superior meridian, and *vice versa;* and this reversal would also occur on the upper meridian, on the sun and moon passing the lower.

20. If the attraction of the sun and moon have any influence at all on the direction and force of the winds within the tropics, these changes must be manifested whenever the distribution of temperature in the atmosphere is such as to admit of it. Such was really found to be the case; for, during the cooler months in the West Indies, when the sun was to the south of the equator, and the moon passed the meridian about the

same time, their conjoint effect being to accelerate the trade, I have often found the wind in the morning very slight, and as they approached the meridian it increased, and by mid-day blew very fresh; between 3 and 4 P.M. it began to decrease, and remained slight during the night, and the following day again ran through the same course, commencing a little later.

21. During the summer and autumn, on the contrary, when the moon's declination is nearly at its northern limit, especially about the period of conjunction, as she passes the meridian, the trade-wind to the southward of these points, through the zenith of which she moves, is checked in its onward progress, while the equatorial current is equally accelerated through the same space; consequently, at the southern limit of the trade, the air will nearly be in a state of quiescence, and it will farther have a tendency to ascend, and to join the returning current above at a more northerly latitude than, but for the attraction of the moon, it would have done, or, in other words, the equatorial limit of the trade will be removed considerably to the northward. Now, as the lower portions of the atmosphere over the sea, within the tropics, have a tendency to the formation of an easterly breeze when the equatorial limit of the NE. trade is removed to the northward, these, being acted on by the same attraction which caused the alteration of the margin of the trade, will be drawn to the northward, and at the same time preserving an easterly direction, more or less, will appear as winds from ESE., SE., or SSE., and even south.

22. Again, when the moon approaches the inferior meridian, the effect of her attraction being to accelerate the NE. trade throughout its whole course, the south-easterly breeze should disappear, and the trade be re-established in its place; but, as the new direction of the breeze was more or less opposed to that it previously had, and as the cause of the new direction acted but a short time at once, a brisk trade is seldom to be expected. Frequently the force of the breeze is diminished only, or the currents from opposite points continue, one flowing above the other, the NE. or trade-wind being generally the lower. Similar effects are produced about the period of full as at that of new moon; and for the intermediate points they

vary according to circumstances. All these modifications I found to be exhibited at Barbadoes with much regularity by the trade-winds, though, from the nature of the subject, a perfect conformity was not to be looked for.

23. Wherever the inner margin of the trade-winds rests upon the sea, it is obvious that a considerable portion of the air, as it ascends the atmosphere, must still retain its tendency to the formation of an easterly breeze, and will accordingly give rise to a returning current from the SE. (21) to the northward of the equator, and from the NE. to the southward of it. As, during the summer and autumn, the equatorial margin of the trade to the eastward of Barbadoes was over the open sea, traces of this breeze were then visible almost every day. Its influence is very commonly experienced along the outer margin of the trade-winds, when its elevated temperature, and high dew-point, unequivocally indicate the locality from which it came.

24. Instances in which the wind gradually drew from NE. to the southward of E., as the sun or moon passed the meridian, were common enough; but the change occasionally occurred without the agency of any such cause. On the 24th September 1841, for instance, the wind at Barbadoes was from ENE. all day. The sun's declination was about 1° S., the moon's hour of transit $7^h\ 47^m$ P.M., and her declination then 21° S. At 2 A.M. on the 25th, it commenced to blow hard, with heavy squalls from NE. and continued so for a considerable time. By 6 A.M. the wind was SE. and fresh, the lower clouds (cumuli) moving from the same point, and above them some cirro-strati from the northward. The wind continued from SE. during most of the day, but gradually diminished in force; at 9 P.M. there was a slight breeze from ENE. On this occasion, though the strong breeze from the northward at 2 A.M. may fairly be ascribed to the attraction of the moon on passing the meridian with a high southern declination, assisted by that of the sun passing the lower a few hours afterwards, still the wind had veered to the SE. before the moon passed the lower meridian, and, consequently, before the attraction could have operated efficiently in changing its direction. Now, it is clear, that, if the trade-wind over any portion of the earth's surface

flow with greater velocity than it does in the adjoining parts, the quantity of air in a vertical column of the atmosphere, at that point, must be proportionately diminished; the atmospheric pressure, then, would consequently be less than all round, and the air would flow inwards towards it from the neighbourhood. To the westward, the air being no longer supported as usual, the wind would back to NNE. and N., while, to the eastward, it would equally veer to ENE., and a little more to the southward to E. These currents flowing rapidly from various points, joining that which was previously moving from the NE., would gradually assume the same direction, still retaining their onward velocity however, and would hence prevent the restoration of the atmospheric pressure. The trade to the SE. of this point, then, impelled by the excess of pressure then over that to its NW., would also flow inwards at first from ESE., and farther to the south from SE. In this manner only could the change above mentioned have originated, though the moon, on passing the lower meridian, shifted the inner margin of the trade to the northward (19, 21), and the wind accordingly remained at SE. all the subsequent day.

25. Immediately beyond the polar margins of the trades, the winds are more or less variable; but, owing to the existence of the equatorial current from the SW. high in the atmosphere, which frequently becomes directed downwards to the earth's surface, the general tendency of the lower portions of the atmosphere there is to move from the westward. When a current moving from the SW., having its velocity diminished by friction on the earth's surface, is subjected to the indraught to the equator which exists about the outer margin of the trade, a greater or less amount of it will be drawn towards the equator again, still retaining its westerly motion, and will thus constitute a NW., NNW., or N. wind, to the north (and, in like manner, a NW. current will be changed to a SW., SSW., or S. breeze, to the southward) of the line, according to the relative amount of its retained and acquired velocities. This current, from its high temperature, and dew-point, would naturally float higher in the atmosphere than the

regular trade, which is usually less marked in these respects; and, at Barbadoes, it was usually found to be above both the trade and the south-easterly current described above. Such seems to be the origin of the north-westerly and south-westerly currents which are seen within the range of the trade-winds, on either side of the line respectively, and which, it will be readily understood, have a very important bearing on the subject of the storms of these latitudes.

26. These north-westerly currents in the atmosphere were perceived at Barbadoes, both when the moon had her greatest northern or southern declination, and when she was in the intermediate points, and therefore seemed to be quite independent of her position with regard to the equator. Although not observed very often, still that does not disprove their frequent existence. This opinion is corroborated by the fact that, when the equatorial current could be distinguished by the drift of a free cirri or cirro-strati, these usually presented the characters of a cymoid cirro-stratus, that is, a group elongated in the line of drift, but the separate portions of which were in lines almost perpendicular to that direction, clearly indicating the existence of the crossing current which led to its formation.

27. On a few occasions the north-westerly current was directed downwards to the earth's surface, and on one, the 30th August, formed a strong breeze from that point. During the two previous days the wind had been very slight, varying from ENE. to SSE; the moon's declination on the upper meridian in the same time decreased from 20 S. to 11 S., her hour of transit being delayed from $9^h\ 52^m$ P.M. to $11^h\ 20^m$. Under these circumstances, the inner margin of the trade being evidently to the northward of Barbadoes, as the moon approached the meridian on the evening of the 30th August, causing a partial flow of the quiescent air over the earth's surface to the southward, the north-westerly current (of which there had been no previous trace that day) fell downwards to supply its place, and at 9 P.M. was experienced as a strong NW. wind. It is worthy of remark too, that, while the wind below was NW., a current from the SE. was flowing rapidly above. During

the night the north-westerly wind disappeared, and next morning, at 5 A.M., there was only a gentle breeze from the NE.

28. Between the equatorial margins of the trades, in the Atlantic, the wind, according to Horsburgh, is variable, but mostly from the SW. A similar, but more decided disposition of the winds, is observed in the Indian Ocean, in which, during what is called the westerly line monsoon, the winds from the equator to lat. 10° or 12° S, or the space between the equatorial limit of the NE. monsoon to the N., and the SE. trade to the south of the line, flow from the W., NW., or NNW. At Barbadoes the same tendency was observed on several occasions. On the 9th of September, the moon's declination being 27° N., and her hour of transit 6^h 33^m A.M., and the sun's declination about 5° N., there was a fine breeze from SE. and SSE. at 5 and 9 A.M, respectively, which gradually died away towards noon. The sky at 9 A.M. was perfectly overcast, and continued so during the day. The equatorial margin of the trade was evidently to the northward of the island. Under these circumstances, about mid-day the barometer began to fall rapidly, so much so, that a hurricane was expected. At 1 P.M. a slight breeze sprung up from SSW., and a very heavy sea began to run into Carlisle Bay, clearly shewing that a fresh breeze from the same point had prevailed at sea, a short distance from the island.

29. The immediate cause of the fall of the barometer in this instance, seems to have been the following: The moon having passed the meridian at 6^h 33^m A.M., with a high northern declination, produced a brisk breeze from the SE. or SSE., which, as the sun approached the meridian, gradually declined. The sun's declination was then 5° N., and the point to which both his attraction and calorific effect, tended to clear the atmosphere, was consequently the parallel of lat. 5° N. The conjoint influence gradually overcame the motion of the lower portions of the atmosphere to the northward at Barbadoes; but, before their motion could be reversed, it was necessary both that those portions lying between lat. 5° N. and the latitude of Barbadoes (13° N.) should be drawn to the southward, and that sufficient time be given for the air over Bar-

badoes, to take up the motion. That the process had commenced was evident from the falling of the barometer; but, before it was completed, the equatorial current, flowing in the opposite direction, had penetrated the lower stratum of air at a weak point, and, coming in contact with the earth's surface, had produced the phenomena already described.

30. Another instance of the wind being experienced from the SW. at Barbadoes, though still more interesting in connection with the present inquiry, occurred on the 6th October. The sun's declination was then about 5° S.; the moon's hour of transit was $4^h\ 28^m$ A.M., and her declination on the meridian 26° N. At 9 P.M. on the 5th, the wind was SE. and fresh, and continued from this point at 5 and 9 A.M. of the 6th. About 10¼ A.M. large cumuli and nimbi began to form rapidly to the S. and SW., accompanied by thunder, lightning, and much rain. By mid-day it was quite overcast, and about 1 P.M. the breeze freshened from the SE., with thick rain and thunder; towards 2 there was a comparative lull for a few minutes, which was immediately followed by a squall from the SW., that continued for about half an hour, with very heavy thunder, and much rain; towards 3 P.M. the wind fell, the rain ceased, and a slight breeze came on from ENE. At this hour the clouds were chiefly flying from the SE. over the ENE. current, and above the S.E. current there were traces of that from the SW. distinguishable. The same night H. M. ship Hecla experienced heavy weather from the eastward, for five hours, between St Lucia and Barbadoes.

31. In this instance the inner margin of the trade was to the northward of the island, a circumstance favoured by the moon passing the meridian early in the morning, with a declination of 26° N. As the sun approached the meridian, the temperature he communicated to the atmosphere still farther favoured the ascent of the air from the earth's surface, and its junction with the southerly currents flowing off to the northward above (19); a diminution of pressure thereby occurred, towards which the air flowed from other points with increased velocity. The sun being 10° farther south than on the previous occasion (28), his influence, in reversing the direction of

the wind as he passed the meridian, was but slightly manifested.

32. It is to be remarked that, when the SE. breeze (30) lulled, the wind did not gradually draw round by S. to SW., but shifted suddenly to the latter point with great violence. Now, when two currents exist in the atmosphere, flowing nearly at right angles to each other, there must always be a certain space between them, in which the direction of the wind is not very decided, or in which the air may nearly be at rest. Should the two currents be directed downwards to the earth's surface, it is clear that the transition from the one to the other would be marked, not by a gradual veering, but by a lulling of the first, and then, after a variable interval, by the more or less abrupt occurrence of the other in the direction in which it was moving. Slight inequalities and eddies may occur in the interposed stratum of air, but, nevertheless, the main features of the case will be as mentioned.

33. It does not involve an absurdity to suppose that the equatorial current, in these instances, was experienced at a point to the southward of the inner margin of the trade; for the winds at Barbadoes, up to the 7th September, and on the 4th and 5th October, were from the north-eastward, and there would, in consequence, be a returning current at some elevation in the atmosphere, not only then but for some time afterwards. Farther, too, the general tendency of the wind over the northern part of South America, from lat. 4° N. to 10° N., is, according to Humboldt, from the S. from May to October; so that, were the margin of the trade to the north of Barbadoes for several days, the air from the equatorial region would be sufficient to maintain the south-westerly current.

34. It is advisable to demonstrate, more completely, the influence of the moon on the wind around Barbadoes, by examining, in detail, the observations on its direction and force for a number of days consecutively. For this purpose, the period between the 7th and 21st September, during which she passed from the northern to the southern lunistice, seemed best adapted, as the declination of the sun was then considerably less than the latitude of Barbadoes, and consequently the tendency to the formation of a sea breeze (12, 13), whereby

the results would be complicated, not so great as when he was nearly vertical—at the same time that a strong indraught on the South American coast had not yet been fairly established. It is quite clear, that if the action of the moon, in changing the direction, or altering the force of the wind, can be established under any circumstances, it must equally exist under all, though the currents produced by other causes may mask it to such an extent, as to prevent its detection.

35. The sun's declination on the 7th September was about 6° N. The moon's hour of transit 4^h 35^m A.M., and her declination on the meridian, at Barbadoes, 25° N. At 9 A.M. the wind was NE.,* slight, with a current above from S. At 3 P.M. there was a slight breeze from WSW., with currents from NE. and SSE. above, the latter uppermost. On the 8th the moon's hour of transit was 5^h 33^m A.M., and her declination 27° N.; at 5 A.M. the wind was S., a fine breeze; at 9 the same; and at 3 P.M. it was SE., a fine breeze, with a current from ENE. above. The diminution of the force of the NE. wind on the morning of the 7th, which, by 3 P.M., had proceeded so far as to admit of a slight sea breeze from the WSW., while the NE. current continued at some elevation, is remarkable; but the decided change of direction, and increase of force, at 5 and 9 A.M. on the morning of the 8th, is such as cannot be accounted for unless by the attraction of the moon, on passing the meridian with a high northern declination, causing the removal of the inner margin of the trade to the northward (21, 30.) The backing of the wind to SE. at 3 P.M., and the occurrence of a current from ENE. above it, were clearly to be referred to the influence of the sun in restoring the trade-wind over the space to the southward of the island, from which it had previously been removed, though the continuance of the wind at SE. shewed this was incomplete. On the following day, however, though there was a fine breeze from the south-eastward at 5 and 9 A.M., it lulled towards mid-day, and came round to SSW., the cause of which is explained above (29.)

36. On the 10th September the sun's declination was 5° N.,

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* See page 155.

and on the 12th only 4° N. The moon's hour of transit on the 10th was $7^h\ 35^m$ A.M., and her declination 25° N. The wind at 5 A.M. was NE., slight; at 9 ENE., do.; at 3 P.M. it was SE., fine, with a current from ENE. above. On the 11th the moon passed the meridian at $8^h\ 35^m$ A.M., with a declination of 22° N.; at 5 A.M. the wind was ENE., very slight; at 9 SSE., very slight, with a current from ENE. above; and by 3 P.M. it was calm; at 9 there was again a slight air from NE. On the 12th the moon's hour of transit was $0^h\ 33^m$, and her declination 17° N.; the wind at 5 A.M. was S., slight; at 9 SE., fine; and at 3 P.M. calm, with a current above from ESE. The restoration of the trade-wind on the 10th was the natural consequence of the diminution of pressure of the previous day (28,) but the influence of the moon, in suspending it, is still perceptible in its diminished force, and its gradual veering to SE. at 3 P.M. The influence of the moon is also obvious on the morning of both the 11th and 12th, though, at 3 P.M. on each, the neutralizing effect of the sun is manifested by the occurrence of a calm; the current from ESE., however, at some elevation, on the 12th, shews the predominance of the former.

37. From the 13th to the 16th September the sun's declination diminished from about 4° to 2° N.; and that of the moon, on the superior meridian, varied from 11° N. to 9° S., while her hour of transit was retarded from $10^h\ 28^m$ A.M. to $0^h\ 59^m$ P.M. The points to which the attraction of the sun and moon then tended to accumulate the air (19), both on passing the superior and inferior meridians, being situated to the south of Barbadoes, a new series of changes manifested themselves. On the 13th there was a fine breeze from NE. at 5 A.M.; at 9 the wind was SE., and slight; at 3 P.M. SE., fine; and at 9 NNE., slight. On the 14th, at 5 A.M., the wind was still NNE., though very slight; at 9 SE., fine, with a current from ESE. above; it continued at SE. at 3 P.M., but backed to ENE. at 9. On the 15th the wind, at 9 A.M., was ESE., a fine breeze, but with a current above from E.; at 3 P.M. it was ENE., with a current above from SE.; and at 9 still ENE. On the 16th the wind at 9 A.M., was again

ESE., though slight, with a current above from E.; at 3 P.M. SE., with currents from ESE. and ENE., mixed up together, overlying it. The north-easterly direction of the wind, early in the morning, on these days, shewed the general tendency of the lower portions of the atmosphere to move to the southward; and hence the operation of those causes which could produce this. On each, towards 9 A.M., the direction changed to SE. or ESE., and (except on the 15th) continued so until towards evening, when it again backed to the north-eastward. Now the wind being from the NE. all night, an accumulation of the lower portions of the atmosphere to the southward of the island must have been gradually taking place, which was facilitated by the diminished velocity of the currents usually produced in it by the heat of the sun. Under such circumstances, the rapid increase of temperature which occurs after sunrise,* especially over the land, would soon cause ascending currents in the atmosphere; but these would obviously take place at a point where the superincumbent weight was least, and when there was least resistance to their passing off to the northward, or, in other words, towards the outer margin of the accumulation rather than towards its centre. To the southward of this point, the winds would be from the south-eastward (21.) Such seems to be the rationale of the above changes, which, though very complicated, and apparently contradictory, nevertheless admit of complete explanation by recognised physical laws.

38. The sun's declination on the 17th and 18th September was about 2° N. The moon's declination on these days 15° and 20° S. respectively, and her hours of transit 1^h 49^m P.M., and 2^h 39^m A.M. The wind at 5 A.M. on the 17th was E., with a current from SE. above; at 9 NE., a fine breeze; at 3 P.M. ENE., fresh; and at 9 ENE., fine. On the 18th it was, at 5 A.M., E., fine, with a current from SSE. above; at

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* The diurnal curve of temperature, at Barbadoes, reaches its lowest point about 6 A.M., and crosses the line of mean temperature about 7^h 46^m A.M. See Observations on the Temperature, &c., of the Atmosphere at Barbadoes, Edin. New Phil. Journal, June 1843.

9 E., fine, with a current from NE. above; at 3 P.M. E., fresh, with the SSE. current over it. On the moon passing the inferior meridian, early on the morning of the 17th, her declination was about 12° S., and, consequently, the point to which she tended to accumulate the atmosphere 12° N., very nearly the latitude of Barbadoes; that island, therefore, must have been close to the centre of the accumulation. On the temperature of the air increasing after sunrise, the tendency to the formation of an ascending current, along the polar margin of the accumulation (37), would again be produced; but the centre of that being near the island, and an ascending current being produced at its equatorial margin also, the air at Barbadoes would flow to whichever side the amount of the forces acting on it was greatest. That, in the present case, was evidently the south; for the attraction of both sun and moon came into play in this direction, in addition to the indraught to the same point, caused by the heat of the former. Accordingly, on the morning of the 17th, at 9 A.M., the wind had backed from E. to NE., and it freshened considerably as the day advanced, but again declined somewhat in the evening. The moon, on passing the lower meridian with a southerly declination, brought the wind to E. at 5 A.M. on the 18th, while there was a decided SSE. current above it. The backing to NE. was again perceptible at some elevation at 9 A.M.; and the freshening, as the day advanced, just as had been the case on the preceding day, though the wind remained at E.

39. From the 19th to the 21st, the sun's declination was about 1° N. The moon's declination increased from 24° to 27° S., and her hour of transit varied from 3h 31m P.M. to 5h 17m P.M. The wind on the 19th, at 9 A.M., was SE., fresh, with a current from E. above; at 3 P.M. it was ENE., slight; and at 9 N., very slight. On the 20th, at 5 A.M., it was ENE., slight, with a current above from SSE.; at 9 E., fine, with a current above from S.; at 3 P.M. SE., with currents above from ENE. and SE.; and at 9 NE., very slight. On the 21st it was NE., slight, at 5 A.M., with a current above from SSE.; at 9 SE., fine; at 3 P.M. SE., do., with currents from NE. and SSW. above; and at 9 again NE.,

very slight. The moon passed the inferior meridian about 3 A.M. on the 19th, with a declination of 22° S.; and her influence (19) is perceptible in the disappearance of the regular trade by 9 A.M., and the substitution of a fresh SE. wind. This, in its turn, disappeared towards 3 P.M., being succeeded by the trade from ENE., which, by 9 A.M., had backed to N. Much the same series of changes occurred on the 20th, the wind veering from ENE. at 5 A.M. to E. at 9, and freshening, and to SE. at 3 P.M.; while the diminution of force at the last hour, with the intermixture of currents at some elevation, and the subsequent backing to NE. by 9 P.M., sufficiently indicate the influence of the attraction of the sun and moon, and of the calorific power of the former, to restore the trade-wind. On the 21st, almost completely the same was observed; the wind veering from NE. at 5 A.M. to SE. at 9, and freshening; and continuing there at 3 P.M., though then the opposite currents began to appear, which, by 9, had again supplanted the SE. wind, when the regular trade resumed its course.

P.S.—As the above was about to pass from my hands, I fell with the 2d ed. of Mr Howard's Climate of London; and it is but justice to that gentleman to state, that, in it, the probability of the winds at the equator being affected by the moon's declination is pointed out (vol. i., p. 200,) and the conversion of SW. into NW. winds explicitly stated (ibid., p. 201-2.)

(*To be continued.*)

Moon's Hour of Transit, and her Declination on the Meridian ; and also the Sun's Declination.

Date.	Moon's		Sun's Declination.	5 A.M.			9 A.M.			3 P.M.			9 P.M.		
	Hour of Transit.	Declination on Meridian.		Wind.	Force.	Currents.	Wind.	Force.	Currents.	Wind.	Force.	Currents.	Wind.	Force.	Currents.
1841.	h. m.	°	°												
Sept. 1	0 1 A.M.	5 S.	8 N.	ENE.	S.	S.	...	...	....	SE. [1]	F.	ENE., SSE.	E.	S.	....
2	0 42 ...	0 ...		E.	S.	SSE.	E.	F.	SSE., WSW.	E. [2]	F.	ENE.	E.	S.	WSW.
3	1 23 ...	6 N.		ENE.	...	....	ENE.	Fr.	....	ENE.	Fr.	....	...	...	....
4	2 7 ...	12 ...	7 ...	E.	Fr.	....	ENE.	F.	....	ENE.	...	....	ENE.	F.	....
5	2 52 ...	17 ...		ENE.	F.	S.	ENE.	Fr.	....	ENE.	Fr.	....	ENE.	...	S.
6	3 42 ...	21 ...		ENE.	S.	S.	ENE.	F.	SE., S.	ENE.	...	S.	...	...	....
7	4 35 ...	25 ...	6 ...	...	...	....	NE.	S.	S.	WSW.	S.	NE., SSE.	...	...	....
8	5 33 ...	27 ...		S.	F.	SW.	S.	F.		SE.	F.	ENE.	...	...	....
9	6 33 ...	27 ...	5 ...	SE.	F.	SSE.	SSE.	F.		SSW. [3]	S.	S.	...	...	....
10	7 35 ...	25 ...		NE.	S.	....	ENE.	S.	WSW.	SE.	F.	ENE.	NE.	S.	....
11	8 35 ...	22 ...		ENE.	V. S.	....	SSE.	V. S.	ENE.	Calm.	...	....	NE.	V. S.	NNE.
12	9 33 ...	17 ...	4 ...	S.	S.	NNE., SW.	SE.	F.	....	Calm.	...	ESE.	...	...	....
13	10 28 ...	11 ...		NE.	F.	SW.	SE.	S.	SW.	SE.	F.	SW.	NNE.	S.	....
14	11 19 ...	4 ...		NNE.	V. S.	ESE., SW.	SE.	F.	ESE., SW.	SE.	F.	SW.	ENE.	...	....
15	0 10 P.M.	3 S.	3 ...	...	...	....	ESE.	F.	E., SW.	ENE.	...	SE.	ENE.	...	....
16	0 59 ...	9 ...		...	...	....	ESE.	S.	E., SW.	SE.	...	E., SE., ENE., SW.	...	...	....
17	1 49 ...	15 ...	2 ...	E.	...	SE., SW.	NE.	F.	SW.	ENE.	Fr.	....	ENE.	F.	....
18	2 39 ...	20 ...		E.	F.	SSE.	E.	F.	NE.	E.	Fr.	SSE.	...	...	....
19	3 31 ...	24 ...		...	...	....	SE.	Fr.	E.	ENE.	S.	....	N.	V. S.	....
20	4 22 ...	26 ...	1 ...	ENE.	S.	SSE., SW.	E.	F.	S., SW.	SE.	S.	ENE., SE.	NE.	V. S.	....
21	5 17 ...	27 ...		NE.	S.	SSE., SW.	SE.	F.	SW.	SE.	F.	NE., SSW., NNW., SW.	NE.	V. S.	NNW.
22	6 9 ...	26 ...		NNW.	V. S.	ENE., SSE.	SE.	M.	NE., NNW., SW.	SE.	M.	NE., N., SW.	...	...	....
23	6 59 ...	24 ...	0 ...	ENE.	S.	NNE., WSW.	ENE.	F.	NW., WSW.	ENE.	F.	NNE., SE.	...	...	....
24	7 47 ...	21 ...		ENE.	M.	SE., SW.	ENE.	F.	N., SW.	ENE.	F.	SW.	ENE.	F.	N., SW.
25	8 33 ...	17 ...	1 S.	SE. [4]	Fr.	N.	SE.	F.	N., SW.	SE.	S.	NNW.	ENE.	S.	SW.
26	9 16 ...	13 ...		NE.	V. S.	SE., SW.	SE.	S.	SE., ENE.	ENE.	F.	SE., SW.	ENE.	S.	SE., SW.
27	9 58 ...	7 ...		ENE.	S.	....	ENE.	M.	NE., SE.	ENE.	M.	SE., SW.	ENE.	S.	....
28	10 40 ...	2 ...	2 ...	ENE.	M.	SE., N., SW.	...	...	....	SE.	M.	E., NNW., SW.	ENE.	S.	....
29	11 21 ...	4 N.		NNE.	V. S.	ENE., SW.	Calm.	...	E., SE., SSW.	ESE.	M.	NSW.	...	...	....
30	☌	......	3 ...	E.	V. S.	ESE., NNW., SW.	ESE.	M.	NE., SW.	E.	M.	NW., SW.	ENE.	S.	NNW., SW.
Oct. 1	0 4 A.M.	9 ...		ENE.	...	SSE.	ENE.	F.	NNE., SW.	ENE.	...	SSE.	ENE.	M.	SSE., SW.
2	0 50 ...	14 ...		ENE.	V. S.	SSW., WSW.	ESE.	M.	SW.	ESE.	M.	SSE., E., NE., SW.	...	...	....

REMARKS.

[1] At 3h 30m changed to NE., fresh.
[2] At 2 P.M. wind SE.
[3] Heavy sea run into Carlisle Bay to-day at 1 P.M., from SW.
[4] At 6 A.M., wind at 2 A.M. NE., blowing hard, with heavy squalls.

Direction of the Wind, &c.—continued.

Date.	Moon's		Sun's Declination.	5 A.M.			9 A.M.			3 P.M.			3 P.M.		
	Hour of Transit.	Declination on Meridian.		Wind.	Force.	Currents.	Wind.	Force.	Currents.	Wind.	Force.	Currents.	Wind.	Force.	Currents.
1841.	h. m.	°	°												
Oct. 3	1 39 A.M.	18 N.	4 S.	E.	S.	ESE., SE., SW.	ESE.	F.	SSE., SW.	ESE.	M.	SSE., N.	NE.	S.	SSE., SW.
4	2 32 ...	23 ...		ENE.	...	S.	ENE.	M.	SSE., SW.	E.	S.	N., S., SW.	E.	S.	....
5	3 28 ...	25 ...	5 ...	ENE.	Fr.	ESE., NNW.	ENE.	Fr.	SSE.	NE. [5]	V. S.	SSE.	SE.	Fr.	....
6	4 28 ...	26 ...		SE.	M.	E., SSE., SW.	SE.	M.	....	ENE. [6]	S.	SE., SW.	ENE.	S.	....
7	5 28 ...	26 ...		E.	S.	ESE., SSE., SW.	ESE.	F.	SSE.	ESE.	...	SE., SSW.	ENE.	S.	....
8	6 28 ...	23 ...	6 ...	ENE.	S.	SSE.	ESE.	M.	E., SSE.	ESE.	M.	SSW.	...	...	....
9	7 25 ...	19 ...		...	...	....	ENE.	S.	SSE.	ENE.	M.	SSE., SW.	ENE.	S.	....
10	8 18 ...	14 ...		...	...	....	E.	F.	SSE.	ENE.	S.	SSE.	E.	M.	....
11	9 9 ...	8 ...	7 ...	...	...	....	ENE.	M.	SSE., SW.	SE.	Fr.	E.	E.	S.	....
12	9 59 ...	3 ...		E.	Fr.	ESE.	E.	Fr.	SE.	E.	Fr.	SE.	...	...	....
13	10 48 ...	5 S.	8 ...	ENE.	M.	NNW.	ENE.	M.	N., SW.	E.	M.	SW.	ENE.	S.	....
14	11 37 ...	12 ...		E.	S.	SE., NNW., SW.	ENE.	M.	SE.	ESE.	M.	E., NW.	ENE.	...	....
15	0 27 P.M.	17 ...		...	...	....	ESE.	M.	ENE.	ESE.	M.	SW.	...	...	....
16	1 19 ...	22 ...	9 ...	ENE.	S.	N.	ESE.	M.	E.	ESE.	M.	E.	ENE.	...	....
17	2 12 ...	25 ...		...	...	....	ENE.	M.	SSE.	E.	M.	....	ENE.	...	....
18	3 6 ...	26 ...		ENE.	V. S.	....	ENE.	F.	....	ENE.	M.	SE.	ENE.	S.	....
19	4 0 ...	27 ...	10 ...	...	...	....	E.	M.	SW.	E.	M.	SW.	ENE.	S.	....
20	4 51 ...	25 ...		ENE.	S.	SW.	E.	S.	SW.	ESE.	M.	E., SW.	...	...	....
21	5 43 ...	23 ...		ENE.	V. S.	....	ENE.	M.	SW.	ESE.	M.	ENE., SW.	ENE.	S.	N., SW.
22	6 27 ...	19 ...	11 ...	NNE.	S.	ENE., SE., SW.	...	...	....	SE.	M.	ENE., NW., SW.	...	...	....
23	7 11 ...	15 ...		...	...	....	E.	M.	SE., SW.	ENE.	M.	SE., SW.	ENE.	M.	SW.
24	7 53 ...	10 ...	12 ...	...	...	....	ENE.	F.	NW., SW.	NNE.	Fr.	ENE., NNW., SW.	ENE.	M.	NNW., SW.
25	8 34 ...	5 ...		...	...	....	ENE.	S.	NNW., SW.	ENE.	S.	SW.	ENE.	S.	NNW., SW.
26	9 16 ...	1 N.		...	...	....	ENE.	M.	N., SW.	ENE.	M.	N., SW.	ENE.	M.	NNW., SW.
27	9 58 ...	6 ...	13 ...	...	...	....	...	...	....	ESE.	M.	E., SW.	...	...	....
28	10 43 ...	12 ...		...	...	....	ENE.	M.	E., SW.	ESE.	M.	ENE., N., SW.	ENE.	S.	N., SW.
29	11 32 ...	17 ...		...	...	....	SE.	S.	WNW., SW.	SE.	S.	N., SW.	...	...	....
30	☌	......	14 ...	...	...	....	ENE.	S.	SSE., SW.	ENE.	V. S.	NNW., SW.	ENE.	...	SW.
31	0 24 A.M.	22 ...		...	...	....	SE.	S.	SW.	SSE.	M.	N., SW.	SSE.	...	....

REMARKS.

[5] Wind SSE., fresh from 1 to 2½ P.M.

[6] Wind SE., fresh at 1 P.M., veered to SW. suddenly about 2, afterwards lulled and backed to ENE.

The currents are put down in the order in which they occurred in the atmosphere, commencing with the lowest.
In column of the force of the wind V. S. signifies very slight; S. slight; M. moderate; F. fine; Fr. fresh.

On the Languages of the Oregon Territory. By R. G. LATHAM, M.D. Communicated by the Ethnological Society of London.*

The languages dealt with are those that lie between Russian America and New California. It is only, however, such as are spoken on the sea-coast and on the American frontier that are fairly known to us. Concerning some of the latter, such as the Blackfoot, the notices are deferred. Little, in the present state of our knowledge, can be attempted beyond the mere verification of vocabularies. In his list, however, of these, the writer has attempted to be exhaustive.

It is convenient to enumerate these vocabularies separately, and to proceed from North to South.

Queen Charlotte's Island.—The two chief vocabularies are Mr Tolmie's and Messrs Sturgin and Bryant's, in the Journal of the Geographical Society and the Archæologia Americana respectively. They represent different dialects.

ENGLISH.	STURGIN & BRYANT.	HAIDAHG, TOLMIE.
Man	keeset	kleilhatsta
Woman	kna, ana	tsata
Canoe	cloo	kloo
Tobacco	quil	quil
Water	huntle	huntle
Sun	tzue	shandlain
Moon	kuhn	khough
Rain	tull	tull
Snow	tull hatter	dhanw
Dog	hah	hootch
Bear	tunn	tann
I.	cagen	teea
Thou	tinkyah	tungha

With these, the few words in the Mithridates coincide.

	MITHRIDATES.	MR TOLMIE.
One	sounchou	squansung
Two	stonk	stung
Three	sloonis	klughunnil

Chimmesyan.—Mr Tolmie's vocabulary—Journal of Geographical Society. Spoken between 53° 30′ and 55° 30′ N. L.

Billechoola.—Mr Tolmie's vocabulary; *ibid.* Spoken on the Salmon River.

Friendly Village.—In Mackenzie's Travels, we find a few words from a tribe on the Salmon River. Their locality is called by Mackenzie the *Friendly Village*. By the aid of Mr Tolmie's vocabularies, we can now place this hitherto unfixed dialect. It belongs to the Billechoola tongue.

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* Read on the 11th December 1844.

ENGLISH.	FRIENDLY VILLAGE.	BILLECHOOLA.
Salmon	zimilk	shimilk
Dog	watts	watz
House	zlaachle	shmool
Bark-mat	zemnez	. . . . .
Cedar-bark-blanket	. . . . .	tzummi
Beaver	couloun	couloun
Stone	dichts	quilstolomick
Water	ulkan	kullah
Mat	gitscom	stuchom
Bonnet	ilcaette	kayeete

Fitz-Hugh Sound.—For these parts we possess only the numerals. They coincide most with the Haeltzuk, a language that will next be noticed. The termination in *skum* is common to the Fitz-Hugh Sound and the Blackfoot numerals.

English,	*two.*
F. Sound,	malscum.
Haeltzuk,	malook.
English,	*three.*
F. Sound,	utascum.
Haeltzuk,	yootook.
English,	*four.*
F. Sound,	moozcum.
Haeltzuk,	moak.
Billechoola,	moash.
English,	*five.*
F. Sound,	thekaescum.
Haeltzuk,	skeowk.
Billechoola,	tzeiuch.
English,	*six.*
F. Sound,	kitliscum.
Haeltzuk,	katlowk.
English,	*seven.*
F. Sound,	atloopooskum.
Haeltzuk,	malthlowsk.
English,	*ten.*
F. Sound,	highioo.
Haeltzuk,	aikas.

Haeltzuk.—Mr Tolmie's vocabulary. Spoken from 50° 30′ to 53° 30′ N. L.—*Journal of Geograph. Soc.*

Quadra and Vancouver's Island—Nootka Sound.—For these parts we have several vocabularies.

1. The Numerals.—From Dixon—*Mithridates*, iii., 2, 115.

2. King George's Sound.—The Numerals. *Mith.*, iii., 2, 115.

3. *Mozino's* MS. *Vocabulary.*—See *Mith.*, iii., 2.

4. *Captain Cook's Vocabulary.*—This is comparatively copious. It represents the same language with the three preceding.

5. The Tlaoquatch vocabulary of Mr Tolmie. *Journ. of Geog. Soc.*—This certainly represents, as is truly stated by Dr Scouler, the same language as the Nootka-Sound vocabulary of Cook.

ENGLISH.	COOK'S NOOTKA.	TOLMIE'S TLAOQUATCH.
Sky	naas	naase
Mountain	noohchai	notcheh
House	mahtai	maas
Paddle	oowbabbie	oowhapie
Canoe	shapats	tshappits
Water	chauk	tchaak
Go	cho	tcha alche
Run	kummiitchchutt	kumitkok
Bow	moostatte	moastatit
Arrow	tseehatte	tzehatite
Knife	kotyok	tzokquaeek
Man	tanass	tanais

6. Straits of Fuca.—A short vocabulary taken during the voyage of the *Sutil y Mexicana*—*Archæol. Amer.*, ii., 306. Is not this Mozino's?

7. The Wakash vocabulary of Jewitt.—*Archæol. Amer.*, ii. 306.

ENGLISH.	FUCA.	TLAOQUATCH.	WAKASH.
Water	ihaac	tchaak	chahak
Sky	tacuihamach	naase	sieyah
Stars	uliusac	taastass	tartoose
Moon	ilajudshashitle	hopulh	oophelth
Sun	dagina	tlopil	oophetlh
Ear	pipi	. . . .	parpee

Kawitchen.—Spoken at the entrance of Trading River opposite Vancouver's Island. Mr Tolmie's vocabulary.—See *Journal of Geograph. Societ.*

Noosdalum.—Spoken in Hood's Channel.—*Ibid.*

The Atna of Mackenzie.—This we may now place. It resembles the Noosdalum, with dialectal differences.

English.	Atnah.	Noosdalum.
Man	scuynlouch	sohwieken
Woman	smoledgensk	sheeakatso
Beaver	schugh	skyauw
Dog	scacah	skacha
Water	shaweliquoih	kah
Plains	spilela	spilchun
Here	thlaelych	lilkaa
Iron	soucoumang	halaitan
Bow	isquoinah	schomotun
Arrow	squaili	ytsh tzimaan

In Baer's *Statistische und Ethnographische Nachrichten über de Prussichen Besitzungen an der Nordwestküste von America*, we find a second vocabulary named *Atna.* This is spoken on the Copper River in Russian America, and represents a different language from the Atna of Mackenzie. Both, however, belong to the same group. The plausible mode of accounting for this coincidence, is to suppose that two tribes named themselves *men*, which throughout the Athabascar languages is expressed by the root *t-n*, as *dinnie*, *tenni*, *tnain*, &c.

Squallyamish,—Spoken at Puget's Sound. Mr Tolmie in T. G. S.

Chenook.—For the important languages of the Chenook or Flathead Indians on the river Columbia, we have the following *data :*

1. Franchere's vocabulary ; *Archæol. Americana*, ii., 379.
2. Parker's vocabulary ; communicated in M.S., by A. Gallatin to Dr Prichard.
3. Cathlascou of Tolmie, J. G. S.
4. Chenook of Tolmie, *ibid.*

Of these vocabularies the Chenook of Parker and Franchere coincide closely. Parker's Chenook, compared with the two vocabularies of Tolmie, agrees most with the Cathlascou.

Kalapooiah.—This tribe is placed by Parker on the Multomah river. According to Tolmie, their language is spoken on the Wallamat Plains.

1. Tolmie's vocabulary. J. G. S.
2. Parker's vocabulary. M.S. from Gallatin to Dr Prichard.

The two vocabularies represent one and the same language.

Okanagan.—Spoken on Fraser's River. Mr Tolmie's vocabulary, J. G. S. The Okanagan vocabulary enables us to fix the following one :

The Salish.—This is an anonymous vocabulary from Duponceau's collection. *Archæolog. Americ.*, ii, 306. It is evidently closely akin to the Okanagan.

ENGLISH.	SALISH.	OKANAGAN.
Man	ekeltamaiuh	. . . .
Woman	. . . .	tukulthlimeilooch
Canoe	'tleagh	slalthleim
Stars	ko'kusmh	hohooos
Rain	steepais	tepais
Snow	smaikut	smakoot
Water	saioolkh	sauwulh
Mountain	aitsumkummok	atzimmok
Deer	atsooleea	. . . . .
Roebuck	. . . .	klatzeenim
Bear	c'summaitshui	skummachist
Wolf	n'tseeetsan	nutzetzim
One	neo	nuchs
Two	essel	uskul
Three	tsailkis	kaalthleis
Four	moa	moas
Five	tseel	koheil
Seven	seespil	sheespil
Ten	epan	opuniet

Klikelat. Spoken between Fort Nez Perce's, Mount Rainier, and the Columbia Falls.

1. Mr Tolmie's vocab.: J. G. S., 236.
2. Mr Parker's vocab.: M.S. from Gallatin to Dr Prichard.

These represent allied dialects of the same language.

Shahaptan, Nez Perce's.—It is truly stated by Gallatin that the Shahaptan and Klikelat languages are allied.

1. Mr Tolmie's voc.: J. G. S.
2. Mr Parker's voc.: M.S. from Gallatin to Dr Prichard

Jamkallie. Spoken near the sources of the Wallamat, Mr Tolmie's voc.: J. G. S.

Umpqua.—On the river so called. Mr Tolmie's vocab.: J. G. S.

This is the most southern point for which we possess Oregon vocabularies.

Four more vocabularies complete the enumeration of our *data* for the parts in question.

1. *Shoshonie, Snake Indians.*—The first is a southern or central one, the Shoshonie or Snake vocabulary, collected by Say, and representing a language south of that of the Nez Perces. *Archæol. Americ.*, ii. 306.

2. *Sussee.*—The Sussee of Umfreville, is either spoken

within the Oregon Territory, or within the districts immediately to the north of it.

3. *The Nagail.* See *Mackenzie's Travels.*

4. *The Tacullí.* See *Archæol. Americ.*, ii. 305.

Such are the vocabularies for the Oregon Territory of North America. In number they amount to forty-one. Dealing with speech as the instrument of intercourse, it is highly probable that these vocabularies may represent as many as nineteen different languages, that is, modes of speech, mutually unintelligible. Dealt with, however, ethnologically, their number is evidently capable of being reduced.

In the present state of our knowledge, it is convenient to leave the Shoshonie language* unplaced. All that we possess of it is the vocabulary noticed above. It consists of only twenty-four words. Their affinities (such as they are) are miscellaneous

English,	*beaver.*
Shoshonie,	hanish.
Chenook,	eena.
Haidah,	tzing.
Cathlascou,	kanook.
English,	*salmon.*
Shoshonie,	augi.
Haidah,	swaggan.
English,	*horse.*
Shoshonie,	bunko.
Blackfoot,	pinnechometar.
. . . . . .	pennakomet.
English,	*woman.*
Shoshonie,	wepee.
Souriquois,	meboujou.
Penobscot,	m'phenim.
Micmac,	epit.
Echemin,	apet.
Pima,	uba.
Calapooiah,	apomeik.
English,	*friend.*
Shoshonie,	hauts.
Chetimacha,	keta.
Onondago,	ottie.
English,	*water.*
Shoshonie,	pa.
New Sweden,	bij.
Algonkin,	ne-pi, *passim.*

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* Since this statement was read, the author has been enabled, through the means of a Cumanche vocabulary, with which he was favoured by Mr Bollaert, to determine that these two languages are allied.

English,	*good.*
Shoshonie,	saut.
Shahaptan,	tautz.
Pima,	tiuot.
Choeta,	chito = *great.*
Crow,	esah = *great.*
. . . .	bassats = *many.*
English,	*go.*
Shoshonie,	numeraro.
Kawitchen,	namilthla.
English,	*come.*
Shoshonie,	keemak.
Nez Percés,	come.
English,	*awl.*
Shoshonie,	weeu.
Ahnenin,	bay.
English,	*no.*
Shoshonie,	kayhee.
Ahnenin,	chieu.
Potowotami,	cho.
Ojibbeway,	kaw.
Ottawa,	kaween.
Old Algonkin,	kah.
Chetimacha,	kahie.

It is also advisable to deal cautiously with the Sussee language. Umfreville's vocabulary is short, and consisting almost exclusively of the names of articles of commerce. Lists of this sort are of little value in ethnography. Still, upon the whole, it confirms the current opinion as to the place of the Sussee language, viz. that it is Athabascan. At any rate, it has certain miscellaneous affinities.

English,	*eye.*
Sussee,	senouwoh.
Kenay,	snaga.
Taculli,	onow.
Chipewyan,	nackhay.
English,	*fire.*
Sussee,	coo.
Chipewyan,	coun.
English,	*kettle.*
Sussee,	ussaw.
Taculli,	osa.
English,	*axe.*
Sussee,	chilthe.
Taculli,	chachil.
English,	*knife.*
Sussee,	marsh.
Illinois,	mariesa.
Minitaree,	matse.
English,	*shoes.*
Sussee,	siscau.
Taculli,	kiscoot.

English,	*one.*
Sussee,	uttegar.
Eskimo,	attowseak.
. . . . .	adaitsuk.
. . . . .	adoajak.
. . . . .	atamek.
English,	*three.*
Sussee,	tanky.
Kenai,	tohchke.
Taculli,	toy.
Chipewyan,	taghy.
English,	*four.*
Sussee,	tachey.
Kenai,	tenki.
Taculli,	tingkay.
Chipewyan,	dengky.
English,	*seven.*
Sussee,	checheta.
Mohawk,	chahtahk.
Onondago,	tschoatak.
Seneca,	jawdock.
Oneida,	tziadak.
Nottoway,	ohatay.
English,	*ten.*
Sussee,	cuneesenunnee.
Chipewyan,	canothna.

Laying these two languages aside, and reserving the Blackfoot for future inquiries, the other vocabularies are referrible to two recognized groups. The Nagail and Taculli are what Gallatin calls *Athabascan.* All the rest are what Pritchard calls *Nootka-Columbian.* Respecting the former class, the evidence is unequivocal, and the fact generally admitted. Respecting the latter, the statement requires consideration.

At first glance, Mr Tolmie's vocabularies differ materially from each other; and only a few seem less unlike each other than the rest. Such are the Kliketat and Shahaptan, the Calapooiah and Yamkallie, the Kawitchen and Tlaoquatch, the Chenook and Cathlascou. Besides this, the general difference between even the allied vocabularies is far more visible than the general resemblance. Finally, the numerals and the fundamental terms vary in a degree beyond what we are prepared for, by the study of the Indo-European tongues.

Recollecting, however, the compound character of the most fundamental words, characteristic of all the American language; recognising, also, as a rule of criticism, that in the same class of tongues the evidence of the numerals is unimportant in the determination of *differences*, and comparing the sixteen Oregon vocabularies of Mr Tolmie with each other, we may satisfy ourselves as to the radical unity of the group. To these lists, and to the accompanying paper of Dr Scouler, reference is accordingly made. The *value* of these groups (the Athabascan and the Nootka-Columbian) is a different and a more difficult question. The *maximum* difference between any two known languages of the Athabascan group is that between English and German. The *maximum* difference between the most unlike languages of the Nootka-Columbian group is that between the modern Greek and Portuguese, *i. e.* the most distant tongues of the classical stock of the Indo-European tribe. Hence, the terms in question are equivalent to the more familiar terms, *Gothic*, *Celtic*, *Slavonic*, &c. All this, however, is illustration, rather than absolute arrangement; yet it serves to give definitude to the current opinions upon the subject.

To the current views, however, the writer takes exception. He considers that the groups in question have too high a value; and that they are only equivalent to the primary subdivisions of *stocks* like the Gothic, Celtic, and Classical, rather than to the stocks themselves. Still less can they have a higher and more exaggerated value, and be dealt with as equivalent to groups like the *Indo-European*.

Hence, the differences between the Athabascan languages of the Oregon and the Nootka-Columbian languages of the Oregon, are the differences between the Latin and Greek, the Welsh and Gaelic, the German and Icelandic, rather than those between the German and Russian, the Latin and Persian, the Greek and Lithuanic, &c.

In determining the higher and more comprehensive class, we must take in a third group of languages. These are those of Russian America. They have generally been referred to two groups of uncertain value, viz. the Kolooch and the Eskimo; the former, for the part about Sitca, or Norfolk Sound, the latter for the parts about the Island of Cadiack, and the Peninsula of Aliaska.

Now, the Athabascan languages are undoubtedly Eskimo; a fact stated by the writer, at the meeting of the British Association at York, and founded upon the comparison of the Athabascan vocabularies of Mackenzie and Dobbs, on the one side, with the Western Eskimo ones, on the other.

And the Kolooch languages are equally Eskimo with the Athabascan. This may be seen by reference to Lisiansky's vocabularies, and a comparison between the Sitca and Cadiack.

ENGLISH.	SITCA.	CADIACK.
Cry	kaah	keya
Drink	itanna	tanha
Hail	katelst	koudat
Knee	kakeek	chiskoohka
Lake	aaka	nanoak
Lips	kahaka	hlukha
Man	chakleyh	shook
Spark	heeklya	chatalahi
Wind	keelhcha	kyaeek

Now, by taking in the Eskimo of the Aleutian Islands, this list might be doubled; and by dealing with the Kenay as Eskimo, it might be trebled.

Again, by attempting to fix the points whereat the Eskimo language ceases, and the Kolooch tongue begins, we may get further evidence that the difference between them is exaggerated; since the languages passed by gradual transitions into each other.

What follows, moreover, is cumulative evidence towards the same conclusion.

Over and above the vocabularies collected by Mr Tolmie that have already been dealt with, there is a seventeenth, viz. the *Tunghaase.* This is stated in Dr Scouler's accompanying paper to be the most northern dialect with which the Hudson's Bay traders come in contact. It is also stated to be Sitcan; and that truly.

ENGLISH.	TUNGHAASE.	SITCA.
Sea-otter	youchts	youtch
River-otter	coostah	kooshta
Bear	hooctch	hoots
Whale	yioagh	yaaga
Woman	shewat	shavvot
Summer	kootaan	kootaan
He	yout	youta
Good	ahkeh	tooake

On the other hand, the Tunghaase has affinities with the

Haidah of Queen Charlotte's Island, and through it with the so-called Nootka-Columbian languages in general.

Cumulative, in the way of evidence to this, is the statement, with the verification of which we shall conclude, viz., that, besides the Athabascan, the other languages of the Oregon Territory have affinities with the Eskimo. With the Oonalashkan and Cadiack on the one side, and with Mr Tolmie's vocabularies (with Cook's occasionally) *en masse* on the other, we have at least the following words common to the two groups.

English,	*sky.*
Cook's Nootka,	eenaeel naa.
Tlaoquatch,	naase.
Oonalashka,	anneliak = *day.*
English,	*sky.*
Haidah,	shing.
Billechoola,	skeonoek = *day.*
Haidah,	yen = *clouds.*
Haeeltzuk,	unnowie.
Oonalaska,	youyan = *sky.*
. . . .	innyak = *sky.*
English,	*moon.*
Billechoola,	tlooki.
Cadiack,	yaalock.
English,	*snow.*
Haeeltz,	naie.
Calapooah,	anoopeik.
Yamkallie,	kanopeik.
Cadiack,	annue.
Oonalashka,	kannue.
English,	*hail.*
Haidah,	dhanw = *snow.*
Oonalashka,	tahenem dahskeeto.
English,	*water.*
Cook's Nootka,	chauk.
Tlaoquatch,	tchaak.
Cadiack,	kooyk = *river.*
English,	*river.*
Tlaoquatch,	aook.
Cadiack,	alaook = *sea.*
English,	*rain.*
Calapooiah,	tochtocha,
Cadiack,	kedok.
Oonalashka,	chetak.
English,	*sand.*
Haidah,	il kaik.
Oonalashka,	choohok.
English,	*mountain.*
Kliketat,	pannatset
Cadiack,	poonhokanlia.

English,	*house.*
Kliketat,	needh.
Shahaptan,	eneedh.
Cadiack,	naa.
English,	*song.*
Cook's Nootka,	eonook.
Oonalashka,	eenoochada = *sing.*
English,	*go.*
Cook's Nootka,	cho.
Oonalashka,	icha.
English,	*cleave, cut.*
Cook's Nootka,	tsook.
Cadiack,	chaggidzu.
Oonalashka,	toohoda.
English,	*crow.*
Cook's Nootka,	kaenne.
Cadiack,	kalmhak.
English,	*fire.*
Cook's Nootka,	eeneek.
Cadiack,	knok.
Oonalashka,	keynak.
English,	*skull.*
Cook's Nootka,	koometz.
Oonalashka,	kamhek.
English,	*teeth.*
Cook's Nootka,	cheecheetsh.
Cadiack,	hoodeit.
English,	*middle finger.*
Cook's Nootka,	taeeai.
Cadiack,	teekha.
English,	*how much.*
Haeeltzuk,	kinshook.
Kawitchen,	quien.
Noosdalum,	quien.
Oonalashka,	kannahen.
Cadiack,	kouhcheen.
English,	*mat.*
Chenook,	swussak.
Shahaptan,	tooko.
Oonalashka,	sootok.
English,	*bow.*
Okanagan,	tsukquenuk.
Oonalashka,	tsaheek.
English,	*house.*
Squallyamish,	aalall.
Oonalashka,	oollon.
English,	*iron.*
Squallyamish,	kumnuttin.
Cadiack,	komlyahook.
English,	*sea-otter.*
Billechoola,	qunnee.
Oonalashka,	cheenatok.
English,	*bear.*
Haidah,	tan.
Oonalashka,	tanhak.

To this list a previous statement applies more truly. By treating the Sitca and Kenay vocabularies as Eskimo, the number of coincidences might have been doubled.

Besides this, it must be remembered that, in Tolmie's vocabularies, no terms expressive of the different parts of the human body are given; and that several names of the commonest objects are wanting, *e.g. fire*, &c.

Neither have the vocabularies of Wrangell for the various dialects of Russian America been made use of.

As the lists, however, stand, the author considers that he has shewn reason for believing that the Athabascan, the Kolooch, the Nootka-Columbian, and the Cadiack groups, are subordinate members of one large and important class—the Eskimo; a fact which, coinciding with all his other inquiries in American Ethnology, breaks down, further than has hitherto been done, the broad and trenchant line of demarcation between the circumpolar and the other Indians of the Western Continent.

On Logarithmic Tables.

Dear Sir,—It would be acceptable to those individuals who use the following tables, to have it in their power to correct the following errors, which, I believe, are not so generally known as they ought to be.

LOGARITHMIC TABLES.

		°	′	″	″	″	″	″	″
Taylor, in 1792,	Cot.	1	35	55					
	Cot.	4	6	31					
	Sin.	4	38	39					
	Cot.	6	18	49					
	Cos.	6	20	5					
	Cot.	6	30	31					
	Sin.	18	2	43					
	Tan.	19	15	26	27	28	29		
	Cot.	19	15	25	26	27	28	29	
	Cot.	21	11	14					
	Tan.	23	48	19					
	Cot.	23	48	19					
	Sin.	25	5	4	5	6	7	8	9
	Tan.	28	19	39					

These having been corrected by the pen in my private copy, I do not recollect what the erroneous figures were, and can find no trace of them in writing.

Callet,
Babbage, Hutton,
Hülsse's Vega,
} No. 102467 log. 010584$\underline{9}$2 for 010584$\underline{0}$2.
} No. 106888 log. 02882$\underline{9}$95 for 02882$\underline{8}$95.

Hülsse's Vega, at log. sin. 12° 10′, Diff. to 1″=97·$\underline{5}$0 for 97·$\underline{6}$0.

In the first four, Callet seems to have committed the original errors, from which the others appear to have been copied without sufficient examination, though great pretensions are made by all to extreme care.

Bagay, Tan. 15° 22′ 0″ log. 9·$\underline{9}$390485 for 9·$\underline{4}$390485.
Sin. 34 40 0 log. $\underline{7}$·$\underline{9}$546604 for $\underline{9}$·$\underline{7}$549604.
Cot. 84 51 9 log. 10·157 (1550).
Cot. 84 51 10 log. 10·157 (1505).

The figures within the parentheses in the last two lines, have been, in my copy, corrected by the pen; and I do not now know what the original figures were.

Shortrede, Cot. 11° 29′ 0″ log. 10·$\underline{9}$621845 for 10·$\underline{6}$921845.
Cos. 13° 25′ 26′ 27′ 28′ 29′ log. $\underline{10}$·987, &c., at top, for $\underline{9}$·987, &c.
Cot. 19° 6′ 7′ 8′ 9′ log. 9·460, &c., for $\underline{10}$.460, &c.

The above specimen, which might be extended, shews that there are as yet no tables extant possessing sufficient accuracy for our public institutions and offices, whatever the professions of authors and editors may be.

You would oblige me by giving these a place in your Journal, so that they may become more generally known.

I am, dear Sir, your obedient servant,

WILLIAM GALBRAITH.

To Professor Jameson.

Remarks on the Cirripedia, with Descriptions of several Species found adhering to Vessels from Ichaboe, on the West Coast of Southern Africa. By WILLIAM MACGILLIVRAY, A.M., LL.D., Professor of Natural History in Marischal College and University, Aberdeen. (Communicated by the Author.)

Continued from p. 305 of vol. xxxviii.

CINERAS. SOFT BARNACLE.

Animal oblong, somewhat compressed, gibboso-convex on the back, incurvate, with the mouth very prominent, and furnished with a pair of external, partially adnate pointed palpi, and three pairs of incurvate, compressed, maxillary appendages, of which the thin terminal lamina is ciliated with spines or bristles; the body narrowed behind, with twelve pairs of pedicellate, long, tapering, incurvate, multiarticulate, lobulate, ciliate cirri; two branchial filaments at the base of the first foot, and a very short one on several of the rest, on each side.

Tegmen compressed, ovato-quadrangular, coriaceous, with five distant, very slender, calcareous pieces; two of them elongated, with an oblique submedial process, along the ventral margin; two linear, at the summit; and a long curved dorsal piece meeting the upper two behind; peduncle subcylindrical, fleshy, its epidermic coat continuous with the tegmen; its inner dermic coat continuous with the dermal lining of the tegmen, on the inner surface of which is a layer of pigment arranged in spots or bands.

This genus, instituted by Dr Leach, is composed of Barnacles of which the membranous tegmen resembles a flattened purse or bag, to which a somewhat square form is given by its five marginal pieces, reduced to slender spiculæ. It is closely allied to Lepas, although externally so different, and still more so to Otion.

A Cineras, in fact, is a Lepas of which the calcareous plates are reduced so as to leave the greater part of the envelope membranous; and an Otion is a Cineras of which the calcareous pieces are abbreviated, the dorsal piece reduced to the minimum size, and with two membranous bags appended to the upper part behind. The animal in all is essentially the same; yet Dr Leach, who in his arrangement employs very superficial characters, refers Cineras and Lepas to two different families. It would certainly be more reasonable to make them sections of one genus.

These animals are found adhering, in great profusion, to the planks of vessels that have been on long voyages, as well as to floating wood, turtles, fishes, and other objects. They are generally associated with species of the genera Otion and Lepas.

1. *Cineras membranacea.* Banded Soft Barnacle.

Tegmen ovato-quadrangular, somewhat compressed, gradually tapering into the peduncle; light greyish-blue, with three longitudinal dusky bands on each side, or brownish-grey irregularly dotted or streaked with dusky.

The body of the animal is subovate, somewhat compressed, incurvate, very convex on the back, moderately narrowed behind; anteriorly soft and prolonged into the peduncle, with a very thin membranous integument, which becomes firmer on the hind part; the mouth prominent, with a vaulted, bullate, rounded lip, having externally two thick, adnate palpi, free at the end, curved forwards and inwards, with a long incurved spinose tip, and three pairs of incurvate, compressed, maxillar appendages, lamelliform at the end. The first or outer pair, with the terminal lamina subtriangular, pointed, with six external marginal, acuminate teeth, of which the posterior is very large, and the anterior very minute; the second with the lamina subtriangular, with five short, convex, ciliated lobes; the third or inner narrower and ciliate.

The first pair of feet, shorter than the rest, are placed immediately behind the mouth; the second pair at some distance; the rest close together. The first pair subcylindrical, compressed, obliquely and deeply grooved on the back, with four joints; their cirri short, broad, tapering, with seven joints; the other feet compressed, obliquely grooved, with two joints, and longer, compressed, tapering cirri, the last having seventeen joints; all the cirri lobed and ciliate on the edge next the mouth; the bristles generally ten or twelve on each lobe, in two series, the dorsal bristles very small and adpressed.

At the base of the first foot externally are two long, tapering, branchial filaments; and there is a very small knob at the base of each of the other feet except the last.

The narrowed part of the body, to which the five pairs of abdominal feet are laterally attached, is narrow, smooth, and horny above, transversely grooved or subarticulate beneath. It ends in a very long, slender, tapering tube, usually curved inwards, but, when extended, much exceeding the last cirri in length. At the base of this tube, on the dorsal aspect, is the anus, over which are two oblong, mobile, horny plates.

The general colour of the body is a dingy-grey or whitish, posteriorly darker, the legs and cirri dusky-brown.

There is a transverse muscle attached to the body behind, and on either side to the tegmen; the ovary passes from a third to half way down the pedicle, which is not contracted above, but gradually tapers downwards.

The mantle is very thin, generally of a pale greyish-blue, as is its continuation into the peduncle, but having on each side three longitudinal bands of dusky pigment; these colours distinctly appearing through the epidermis, which is yellowish-grey or brownish, and transparent.

The tegmen subovate, subtetragonal, being obliquely truncate above, moderately compressed, sustained, as it were, by the five very slender calcareous pieces.

The anterior pair nearly straight, linear, very thin, with an oblique oblong process from above the middle, directed upwards and backwards; the upper pieces marginal, linear, slightly recurved, a little divergent anteriorly, generally more divergent behind; the dorsal piece linear, curved convexly below, concavely above, and meeting the upper pieces at the posterior angle.

The peduncle about the length of the tegmen; its internal layer often coloured pale-blue, with or without a continuation of the dusky bands of the tegmen, sometimes light-brown, or pale yellowish-grey.

Very young individuals have the epidermis extremely thin, transparent, the calcareous pieces spicular, the colours paler, generally without the blue tinge.

The general form does not vary much; but that of the calcareous pieces is subject to great variation in form, curvature, and thickness.

Generally, in very small individuals, the dorsal piece projects beyond the upper two, which meet it, and seem as if articulated to it. In older individuals, there is often a considerable space between the summit of the dorsal piece and the upper pieces, which are more or less divergent at the base. These upper pieces are straight, recurved, twisted, linear, or broader at the basal end, sometimes incurved or recurved at the outer. The dorsal piece is nearly straight in very young, often much curved in old, individuals. The fork of the ventral pieces is very conspicuous in young individuals, more or less filled up in old.

Many individuals, large and small, were of a light-brown or yellowish-grey colour, with irregular brown streaks, or crowded dots; but in other respects not different.

Individuals of this species, in all stages, were found in vast profusion, on three of the vessels, adhering to the wood, to pitch, or to each other, and to the Otions and Lepades.

Were characters derived from the precise form of the calcareous pieces, and from the colours of the tegmen and peduncle, to be assumed, as availing for specific distinction, half a dozen species might easily be formed out of this.

The following references are pretty certain:—

Lepas membranacea.	Mont. Trans. Linn. Soc. xi. 182, plate 12, fig. 2.
Lepas membranacea.	Turt. Conch. Dict. 73.
Lepas coriacea.	Poli. Test. i. plate 6, fig. 20.
Cineras vittata.	Leach. Encyclop. Brit. Suppl. iii. 170, plate 57.
Cineras vittata.	Lamk. Anim. s. Vert. v. 684.
Cineras vittata.	Gould, Invert. Massach. 22.
Cineras bicolor.	Riss. Eur. Merid. iv. 383.
Gymnolepas Cranchii.	Blainv. Malac. plate 84, fig. 2.

Dimensions of several individuals:—

	′	″	′	″	′	″	′	″
Length, .	1	6	1	3	1	2	0	6
Depth, .	1	2	0	10	0	10	0	4
Breadth, .	0	8	0	6	0	7	0	2
Peduncle,	1	4	1	2	1	4	0	6

OTION. EARED BARNACLE.

Animal oblong, little compressed, gibboso-convex on the back, incurvate, considerably prolonged anteriorly, with the mouth very prominent, and furnished with a pair of external, partially adnate, pointed palpi, and three pairs of incurvate, compressed, maxillary appendages, of which the thin terminal lamina is ciliated with spines or bristles; the body narrowed behind, with twelve pairs of pedicellate, long, tapering, incurvate, multiarticulate, lobulate, ciliate cirri; the ovarian tube tapering, annulated, longer than the last cirri; three branchial filaments at the base of the first foot, and one on several of the rest on each side.

Tegmen cuculliform, cylindraceo-globose, coriaceous, smooth, with five distant, very small, calcareous pieces; two oblong, geniculate or angulate, at the lower margin of the aperture; two linear at the summit; and an extremely small dorsal; at the top, behind the aperture, two large, subovate appendages, communicating below with the interior of the tegmen. Peduncle cylindrical, fleshy, constricted at the top, its epidermic coat continuous, with the dermal lining of the tegmen, on the inner surface of which is the slight layer of pigment, continuous or interrupted.

This genus, instituted by Dr Leach, but by some united with Cineras, under the common name of Gymnolepas, is composed of very singular-looking animals, which are found adherent to ships' bottoms, floating timber, and many other objects. It is very nearly allied to Cineras, and the species of the two genera are usually found intermixed, and even affixed to each other.

It differs from Cineras in having the two bursiform appendages at the top, and in other particulars; from Lepas in having more branchial filaments, the cirri much shorter, the tegmen almost entirely coriaceous; but still it is closely allied to it, and has the same calcareous pieces, although greatly reduced in size.

These Cirripedia are found in great profusion on vessels that have been on long voyages, as well as on turtles, fishes, and other objects.

Of this genus only one species has occurred.

1. *Otion auritus.* Common Eared Barnacle.

Tegmen cuculliform, cylindraceo-globose, depressed, brown; appendages ovate, puckered, dark-brown; marginal plates oblong, geniculato-angulate, twisted, thick, broader and abrupt above, tapering and obtuse below; upper plates linear; dorsal very minute, oblong, convex; peduncle brown, glistening with bluish-gray, paler at the base.

The body subovate, little compressed, incurvate, very convex on the back, moderately narrowed behind; anteriorly soft and prolonged, with a very thin membranous white or greyish integument, which becomes firmer on the hind part. The mouth forming a large prominence, and having a vaulted, bullate, rounded lip, with two external adnate thick palpi, free at the end, curved forwards and inwards, with an incurved spinose tip, and three pairs of incurvate, compressed, maxillar appendages, lamelliform at the end. The first or outer pair with the terminal lamina subtriangular, pointed, with six external, marginal, acuminate teeth, of which the posterior is very large, and the anterior very minute; the second, with the lamina subovate, with five short, convex, ciliated lobes; the third or inner, narrower and ciliate.

The first pair of feet shorter than the rest, immediately above or behind the mouth; the second pair at some distance, the rest close together; the first pair subcylindrical, compressed, obliquely grooved on the back, with four joints; their cirri short, broad, tapering, with thirteen joints; the other feet compressed, obliquely and deeply grooved on the back, with two joints, and longer, compressed, tapering cirri, the last having seventeen joints; all the cirri lobed and ciliate on the edge next the mouth, the bristles generally ten or twelve on each lobe, in two series; the dorsal bristles very small and adpressed.

The first foot has a long, cylindrical, tapering, branchial filament from its last joint externally, another having a rounded prominence at its base from the next joint, a third very short from the basal part, and not far from it, on the side of the body, a hemispherical knob. The next four feet have each a similar, gradually shorter filament from the basal joint; but the last pair has none.

The narrowed part of the body, to which the five pairs of abdominal feet are attached, is smooth and horny above, transversely grooved or subarticulate beneath. It ends in a very long, slender, tapering tube, usually curved inwards, but when extended much, exceeding the last cirri in length. At the base of this tube, on the dorsal aspect, is the anus, over which are two oblong, mobile horny plates.

The general colour of the body is white or pale yellowish-grey anteriorly, darker behind, the legs and cirri dusky-brown.

There is a transverse muscle, as usual, and the fore-part of the body, which projects far beyond the mouth, is rounded, but tapers into the peduncular tube.

The mantle is very thin, generally pale yellowish-brown, minutely variegated with darker brown, by the pigment.

The tegmen ovato-globose, or subcylindrical, and somewhat compressed, abruptly inflexed beneath, coriaceous, translucent, brown, darker above, the margin of its aperture thick and reflexed; the appendages subovate, bursiform, puckered, and having a large terminal aperture, the dermal lining a continuation of the mantle, and generally perforated at the end; five very small calcareous pieces.

The anterior pair placed obliquely near the lower part of the opening in the ventral margin, oblong, bent in the middle, laterally twisted, thick, with the upper part broad, and abruptly rounded, the lower tapering, narrow, and rather acute below, marked with concentric rugæ, and radiating striulæ; the upper linear somewhat curved, nearly parallel, and ending in two membranous points projecting over the aperture; the dorsal piece extremely small, often scarcely perceptible without a glass, sometimes wanting.

The peduncle generally longer than the tegmen, cylindrical, with a circular groove where it joins the tegmen, smooth, glossy, or glistening, coriaceous, brown, usually tinged with blue, paler toward the base, where it is thicker.

Some remarkable variations are exhibited by this species:—

Young individuals are not so membranous as those of *Cineras membranacea*, but from the first have more or less of the coriaceous firmness of the adult. I find that some of them have no appendages, others two very small prominences, others roundish, subhemispherical, or ovate bodies, always imperforate. In larger individuals, even up to two inches in length, the appendages are often still imperforate, generally ovate, seldom smooth, but mostly puckered in various degrees. As the animal enlarges, they become proportionally longer and more bullate. Sometimes the epidermis at the tip is seen with an irregular slit, sometimes with an interruption having a shred across it, sometimes with a roundish, but usually irregular discontinuity. Still, the inner or dermal membrane may be entire; but at length it opens at the end. In old individuals, there is a wide irregular opening in both membranes, and often the appendages are torn into shreds at the end. In one large individual, one of the ears has a large aperture, while the other has none. Under these circumstances, one may judge what importance can be attributed to characters taken from the auriform sacs, as has been tried by some. I apprehend that those from the precise form of the calcareous plates are equally insufficient.

For example, the anterior plates are very narrow, thin, and little bent in very young individuals; broad above, thick, geniculate, and much twisted in large specimens, obtuse or acute below. The upper valves vary in like manner from linear to subtriangular. The dorsal piece is always extremely small and oblong, or elliptical, but I have seen many specimens large and small, in which it was altogether wanting. I have also seen the two upper pieces wanting, in which case the aperture was not notched above, as it usually is.

The colouring is also subject to variation. Generally the tegmen is deep purplish-brown, with the ears still darker; the peduncle dark-brown above, pale or hyaline-grey below. Often, however, the tegmen is dotted or streaked with brown internally, the ears still more so, and sometimes they are whitish on the inner side and spotted with brown.

I apprehend, therefore, that authors have made more species than nature has presented to them; and that *Otion Cuvierii*, and *Otion Blainvillii*, are one and the same. *Otion Rissoanus* agrees precisely with many specimens of the present species. *Otion sacutifera* of Coates, from the Cape of Good Hope, finds plenty of representatives among my specimens. On all the vessels it was the same species, exhibiting the same variations. The references, then, are:—

Lepas aurita.	Linn. Sys. Nat. 110.
Lepas leporina.	Poli. Test. plate 6, fig. 21.
Lepas aurita.	Brug. Dict. 66.
Lepas aurita.	Cuv. Mem. du Mus. ii. plate 5, fig. 12.
Otion Cuvierii.	Leach. Encyclop. Brit. Suppl. iii. 170, plate 57.
Otion Cuvierii.	Lamk. Anim. s. Vert. v. 685.
Otion Cuvierii.	Gould. Invert. Massach. 23.
Gymnolepas Cuvierii.	Blainv. Malac. plate 84, fig. 1.
Lepas cornuta.	Mont. Trans. Linn. Soc. xi. 179, plate 12, fig. 1.
Otion Blainvillii.	Leach. Encyclop. Brit. Suppl. iii. 178, plate 57.
Otion Blainvillii.	Lamk., Anim. s. Vert. v. 410.
Otion sacutifera.	Coates' Journ. Acad. Nat. Sc. Phil. vi. 132.
Otion sacutifera.	Lamk. Anim. s. Vert. Vesh. v. 686.

Dimensions of several individuals.

	'	"	'	"	'	"	'	"	"	"
Length, . .	0	9½	0	9	0	8	0	7	6	4
Depth, . .	0	9	0	7	0	5	0	5	5	3
Breadth, .	0	6	0	6	5	4	0	4	3	1½
Peduncle, .	2	3	1	6	1	4	1	0	9	4½
Ears, . .	0	8	0	7	0	8	0	5	0	4½

The principal circumstances observed with respect to these five species of Barnacles, generally, are the following:—

They occur on the vessels promiscuously, without any order or predilection as to association.

Five of the vessels were coppered, and one iron.

All the species occurred on the iron vessel, excepting Lepas Nauta, which was met in comparatively small numbers only on one of the vessels.

The Otion and the Cineras occurred on the copper sheathing, but sparsely, and principally on or near the nails, which were more free of oxidation; but they were most abundant on the wood and pitch, just above the sheathing, and about the stern, more than on the sides and bows, and especially on and near the seams.

The Lepades were larger and more numerous on the stern and rudder, both on the wood and on the pitch.

Lepas anatifera and L. incurvata often occurred contiguous, with different bases, and often coherent, one growing on the peduncle of the other. On both species Cineras membranacea grew very abundantly, generally on the peduncles, sometimes on the membrane of the tegmen, seldom on the shell. Otion generally grew independently, but sometimes individuals adhered to each other; and very frequently Cineras adhered to the bases of their peduncles, and to their tegmens.

It does not appear that any corrosive, or otherwise poisonous, substance could be of much avail in preventing their growth, as they do not imbibe nourishment by the base, which is callous. A granular powdery surface, as that of oxidating copper or zinc, would prevent their adhesion in a great measure; and thus, the repeated application of a coating of oil or tallow, mixed with chalk or powdered gypsum, or of some such mixture or substance, adhesive, insoluble in water, but unstable, would, in all probability, prove a remedy.

On five of these vessels were comparatively few Balani; but on a London ship, which I visited on the 16th of February, they were extremely abundant, covering some of the planks almost continuously. These Balani are the only representatives found of the second order of this class of animals.

The CIRRIPEDIA SESSILIA, often named Acorn shells, as well as Barnacles, have the body contained within a conical or cylindrical testaceous tube, affixed by its basis to some solid substance. To this series belong the genera *Balanus*, *Coronula*, and a few others, forming the family of the *Balanina*.

In it the animal is ovate, oblong, or depressed, suspended in a testaceous covering, with the hind part uppermost, but at the upper part having generally four moveable testaceous pieces, which separate anteriorly, as does the mantle, which is prolonged at the other end into the coronary tube or shell; the branchiæ in the form of two fimbriated laminæ attached to the inner surface of the mantle.

BALANUS. ACORN-SHELL.

Animal oblong, somewhat compressed, convex on the back, incurvate prolonged anteriorly, with the mouth prominent, and furnished with a pair of external, adnate, pointed, incurvate palpi, and three pairs of maxillary appendages, of which the thin terminal lamina is ciliated with spines or bristles; the body narrowed behind, with twelve pairs of pedicellate, tapering incurvate, multiarticulate, lobulate, ciliate cirri; the ovarian tube very long, tapering, annulate; the branchiæ lateral, at the fore part of the body, each composed of an oblong generally fibriated mass.

Tegmen compressed or pyramidal above, with four triangular, tapering, pointed plates, forming two lateral valves separating in the median line, and mobile; its dermal lining affixed below to the interior of the coronary tube, which it lines in its whole extent beneath, and is closed at the base.

Coronary tube, or shell, conical, truncate, of six united pieces, presenting externally six triangular elevated areas, broader below, and six narrower depressed areas, broader above; the anterior elevated area largest, the anterior lateral and the dorsal next in size, the posterior lateral very small; the base formed by a calcareous plate, or sometimes membranous; the aperture ovate, triangular, or pentagonal. In the upper part of the coronary tube internally, an accessory calcareous tube composed of six imbricated thin plates.

The species of this genus are very numerous, and, for the most part, very ill described. Some are to be found in every part of the maritime world, adhering to rocks, stones, wood, shells, and other objects. One only has occurred on the Ichaboe vessels.

1. *Balanus porcatus.*

Shell conical, strong, obliquely truncate, with the aperture rather small, subovate; the elevated areas with prominent, straight, compressed, obtuse, white ridges, separated by flattened faintly striate depressions, covered with a reddish epidermis; the depressed areas narrow, flat, shining, finely striulate; the accessory tube transversely distantly lamelloso-striate; the opercular plates transversely rugoso-sulcate, the anterior acute, the posterior with the apex acuminate and incurvate, the base with a narrow process, from which a groove runs to the apex.

Animal ovate, somewhat compressed, with the anterior part of the body very convex on the back, and prolonged anteriorly, where it is attached by two strong muscles to the coronary tube, and by muscular fibres to the lower part of the mantle, and covered with a thin membranous integument, becoming firmer on the lined part, which is short and rather broad. The mouth prominent, with a vaulted, bullate, rounded lip, having externally a pair of adnate, pointed, ciliate palpi, and three pairs of maxillary appendages; the first pair denticulate at the end, the second broad and ciliate, the third more pointed and ciliate.

The first pair of feet very small, and quite close to the mouth; on each side of the hind part of the body five feet, each compressed, obliquely grooved on the back, and bearing a pair of long, compressed, tapering, incurvate cirri, articulated, lobulated on the inner edge, and there ciliate with divergent rows of bristles, generally two or three bristles on each side of each lobule; the last cirri with thirty-five joints.

At the fore-part of the body, and connected with the mantle, on each side, is a large oblong branchial body.

The narrow part of the body, to which the abdominal feet are attached, is rather broad, convex above and beneath, in the latter aspect faintly grooved across. It ends in a very long, slender, tapering, annulated tube, curved inwards, but, when extended, much longer than the cirri. At the base of this tube, between the last two feet, is the anus, in the form of an oblong aperture, without operculum.

The general colour of the body is yellowish-white, posteriorly light reddish-brown: the feet pink, the cirri pale yellowish-grey.

The mantle is very thin, and lines the calcareous plates of the operculum, as well as the epidermis at their base, beyond which it extends, becoming much thicker all round, down to the base of the coronary tube, extending over the basal plate. Within it, the proper envelope of the body is continuous with muscular fibres affixed to the base of the tuube.

The tegmen is of a pyramidal form, membranous below, where it is attached to the base of the accessory calcareous tube, above with the four calcareous pieces, forming two lateral and terminal valves; the anterior plates triangular, oblique, externally concave, very acute, transversely grooved, their posterior margins longitudinally cleft; the posterior plates triangular, incurvate, the base with a narrow process, from which a longitudinal groove runs to the apex, the anterior margins with a shallow groove, and a strong ridge; the free margins of these opercular valves denticulate.

Coronary tube or shell conical, somewhat oblique, and obliquely truncate, of six united pieces, forming six elevated ridged areas, and six depressed narrow areas, which are white, flat, glossy, distinctly striulate transversely and longitudinally, often with some deep transverse grooves. The anterior or ventral elevated areas with about five ribs, and several smaller; the ventro-lateral with four or five, and some smaller; the posterior-lateral with one or two; the posterior with five or more; the ribs straight, compressed, narrow, obtuse, slightly rugose, leaving the base-line crenate; their intervals obscurely striated, and covered with a greyish-brown, or brownish, or purplish-red epidermis. The shell white, or tinged with purple or pink, sometimes in irregular transverse bands.

The accessory or internal shell or tube extends halfway down, and is composed of six imbricated thin plates, glossy internally, with faint transverse striæ. Beyond it the tube is longitudinally grooved on the inner surface, and closed below by a calcareous plate, which is divergently striate. The walls of the tube have numerous narrow, compressed cells, separated by very thin partitions, from the base to the apex of the elevated areas. They are filled with a pulpy cellular tissue, which communicates with the mantle by small apertures at the junction of the basal plate with the shell internally. The articular margins of the six pieces of the shell are transversely grooved.

I have traced it down to the size of one-twelfth of an inch in diameter. It has then a very different appearance; being conical, white, with six plates, of which the summits are obtuse in outline, but thin-edged, and separated from each other, leaving an ovato-pentagonal aperture, about a third in width of the diameter of the base; the elevated areas slightly and irregularly longitudinally rugose; the depressed areas very narrow, glossy, and transversely striulate. In this state they are found solitarily, or crowded on the wood in chinks of the pitch, or sometimes upon the pitch itself, or upon the tegmen of the Otion, in which latter situation, however, they do not attain the diameter of a quarter of an inch before they fall off. As they enlarge, the elevated areas become more rugose, and the tips of the plates become broken; and when their diameter at the base is about two-twelfths of an inch, the strong, prominent ribs begin to be formed. When full-grown, they always have the tips broken or worn off, in various degrees, and the margin of the aperture continuous. As the base continues adherent to the wood, and enlarges in diameter, the shell insinuates itself beneath the pitch, raising it up so as to form a general coating, broken or continuous, from which, up to a considerable size, the aperture only is seen projecting.

It is scarcely probable that this species has not been described; but I am unable to trace it in any work accessible to me. One of the first English malacologists of the present day, informs me, that he has it in his cabinet marked *Balanus porcatus*, although he does not know on what authority. Whether that be the true name or not, it will answer our purpose equally well, it not being my object to characterize new species, so much as, by giving minute descriptions, to afford some correct ideas of the structure of these animals.

	″	″	″	
Greatest diameter, . .	7	6	6	1
Breadth, ...	5	5½	5	¾
Height, ...	3½	5	4½	1
Aperture, ...	1½	2	2	½

Since the above observations were made, in January and February of the present year, several other vessels have arrived from the same place. They presented nothing new, however; but on one of them was a great quantity of *Lepas Nauta*, intermixed with *Lepas anatifera*.

I have been favoured by Dr Dickie with the inspection of a large Balanus, from the rocks at Ichaboe, and by Dr Shier, with several species of Patella, found among the guano. These, and other objects, from the same island, may perhaps be considered worthy of being noticed on another occasion.

ABERDEEN, 10th *June* 1845.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY AND GEOLOGY.

1. *Phosphorescent Rain.*—It was stated to the French Academy of Sciences, that, on the 1st November 1844, at half-past eight in the evening, during a heavy fall of rain, Dr Morel-Deville remarked, as he was crossing the court of the *College Louis-le-Grand*, in Paris, that the drops, on coming in contact with the ground, emitted sparks and tufts (*aigrettes*) of light, accompanied by a rustling and crackling noise; a smell of phosphorus having been immediately afterwards perceptible. The phenomenon was seen three times. M. Duplessy saw at the same hour a remarkable brightness in the northern sky.

2. *Fossil Meteoric Stones.*—The acute Olbers remarks, "It is a fact worthy of attention, and one which has not hitherto attracted notice, that fossil meteoric stones have never been found, like fossil shells, in secondary and tertiary formations. Are we to conclude, that, previously to the last change which the surface of our earth underwent, no meteoric stones had fallen upon it, while at the present day, according to Schreibers, it is probable that seven hundred aërolites fall every year?" (Olbers, in *Schumacher's Jahrbuch*, 1838, 329.) Problematical masses of native iron, containing nickel, ave been found in Northern Asia (near the gold-washing establishment of Petropawlowsk, not quite 100 English miles south-east from Kusnezk) at a depth of 31 feet; and recently in the Western Car-

pathians* (Magura Mountains, near Szlanicz). The masses from both localities are very similar to meteoric stones. (Vide *Erman, Archiv für Wissenschaftliche Kunde von Russland*, vol. i., p. 315; and *Haidinger's Bericht über die Szlanicer Schürfe in Ungarn.*) —*Humboldt's Kosmos*, vol. i., p. 406.

3. *Infusoria in Volcanic Rocks.*—Professor Ehrenberg formerly stated that he had found microscopic animals in flint, which had apparently been exposed to a high temperature, from the north of Ireland; and in an earthy substance eaten by the Tunguses, brought by Erman from the Marekan Mountains, near Ochotsk, which resembled decomposed pumice, and is supposed to be the decomposed rock of the Marekanite. More recently he has examined rocks from the Hochsimmer volcanic hill near the Laacher-See, in one of which Nöggerath had previously suspected the existence of infusory animals. Ehrenberg found that not only the *Polirschiefer* of that locality is entirely composed of siliceous infusoria, but also that a considerable proportion of the tuffs and pumice conglomerates is similarly constituted. The two latter rocks, however, contain the infusoria in a distinctly roasted (*gefrittet*) condition. Thirty-eight species of Polygastrica were found, of which only two are new; and of the thirty-six known ones, thirty-five belong to living species, and only one is tertiary. Infusoria were also found in the pumice of the Kammerbühl; in the Trass of the Brohl-Thal; in a substance resembling adhesive slate, which forms a coating on clinkstone from the vicinity of the Hochsimmer; and in a pumice from Tollo, near Santiago, in Chili. A rock from Arequipa, in Peru, described by Meyen as a decomposed porphyry, proves to be a pure infusory *Polirschiefer*. According to Meyen, the volcano of that locality has never given out lavas, but has only ejected pumice. Many pumices have been examined by Ehrenberg, in which he could discover no organic remains, and some in which he found them only with the greatest difficulty. (*Leonhard and Bronn's Jahrbuch*, 1845, Heft 2, p. 249.)

4. *Materials formerly or at present employed in the construction of the Cathedral of Cologne.*—The principal material of which the cathedral of Cologne is built, is the trachyte of the Drachenfels, in the Siebengebirge. The chief causes which induced the selection of this stone were, that it was known as a useful architectural material from a very early period, and that the quarries, distant only about 20 English miles from Cologne, were quite close to the Rhine, and were, therefore, very favourably placed for cheap transport. As the quarries at the Drachenfels were abandoned, it became necessary, in 1824, to select another material for the restoration and comple-

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* Haidinger mentions that the meteoric iron of the Magura Mountains has been found in such abundance, that it has been employed for practical purposes. Edit.

tion of the cathedral; and Ahlert, at that time master of the works, chose the trachyte of the Wolkenburg, from the quarries of Rhöndorf. This stone, however, is no longer employed. The trachyte of the Stenzelberg is used, in so far as it can be obtained, and is evidently the best building stone of all the trachytes of the Siebengebirge, although it is difficult to work, and its transport is expensive. As the quarries of the Siebengebirge were not sufficient to afford materials for the building operations of the cathedral, Professor Nöggerath, and Councillor Zwirner, master of works, suggested, in 1837, that the trachyte quarry near Berkum, about five miles from Mehlem, should be purchased for the purpose. This proposal was adopted, and a considerable quantity of stone for the plainer parts of the building is obtained from this quarry. Since the year 1834, a trachytic rock from the Perlenkopf, near Hannebach, has also been used; and there may also be enumerated as materials occasionally employed, the porous basalt, or the so-called millstone-lava of Niedermendig and Mayen; the Keuper sandstone of Heilbronn, on the Neckar; the coal formation sandstone of Flonheim, near Kreuznach; and the Bunter sandstone of Udelfangen, near Treves. A portion of the interior of the cathedral has been constructed of a variety of volcanic tufa termed trass by geologists, and frequently called Duckstein on the Rhine, which has been obtained from various quarries in the neighbourhood of the Laacher-See. The figures and carved work of the cathedral have been formed of Weiberstein, a volcanic tufa more homogeneous than trass, which is found near the village of Weibern, about five miles from the Laacher-See. The columnar basalt of Oberwinter has been partly employed for the foundation walls. The mortar which is now used for the structure is obtained from the *Bergkalk* of Paffrath and Gladbach, on the left bank of the Rhine. (*From a Paper by Professor Nöggerath in Karsten's Archiv*, vol. xviii., p. 455.)

5. *Early Composition of the Atmosphere.*—Professor H. D. Rogers submitted to the Association of American Geologists the following communication on the probable constitution of the atmosphere at the period of the formation of coal:—He stated, that the recent researches of American geologists, by informing us of the true quantity of coal in North America, enables us, for the first time, to estimate, with some precision, its total amount on the globe, and thereby to compute the quantity of carbonic acid which the ancient atmosphere must have contained, to supply this body of carbon. He shewed, that the existing atmosphere contains, in its carbonic acid, carbon enough to furnish, through vegetable action, about 850,000,000,000 tons of coal; and that the probable quantity of coal in existence, all of which must have been elaborated from the ancient atmosphere, is nearly 5,000,000,000,000 tons—that is to say, about six times that which the present atmosphere could produce. So great a reduction in the carbonic acid of the

earth's atmosphere, implying, as all chemists are aware, a corresponding augmentation of oxygen, is a fact of great interest to geology, as shewing that very modification in the constitution of the air which would adapt it to the development of animals progressively higher in the scale of organization, which are known to require a more rapid oxygenation of their blood.—*American Journal of Science and Arts*, vol. xlvii., No. 1, July 1844, p. 105.

8. *Ehrenberg's Researches on the Distribution of Microscopic Life.*—A comparison of the microscopic organisms of Europe, with those of other countries, which Ehrenberg commenced some years ago, has now been extended to Asia, Africa, and Australia. Aided by his method of examining the portions of soil adhering to the roots of plants in herbaria, and by contributions from travellers, of algae and earths containing infusoria, he has been enabled to give a comprehensive view of the minute living forms of an immense portion of the surface of the earth.

In his memoir on the Asiatic forms, the author accompanied his remarks, upon the importance of the most careful observation of the minutest organic forms, by the statement, "that the globular concretions of the oolitic limestone of the Jura formation in Germany, as well as in England, appears to be chiefly composed of the shells of Meloniæ."

He alluded to the different views which have been entertained with regard to the origin of the round granular concretions of oolitic limestone, and stated that the idea, that, like peastone, it originated in an incrustation of various small fragments in a former sea, having a high temperature, was improbable and untenable; for among the round granular concretions with concentric coatings, like the peelings of an onion, which might be supposed to have had such an origin, there also often occurred calcareous or siliceous bodies of the same size, which shewed no trace of incrustation; as, for example, spines of Echinæ, encrinital plates, fragments of shells and minute Polythalamia. All these forms which had existed and remained in the same conditions, but which had received no shelly coverings, prove that the shells of many oolitic concretions cannot be incrustations. Besides, the oolitic concretions have generally a very similar limit with regard to size, while, in the formation of peastone, there is no limit.

The author stated that he possessed a piece of oolitic limestone from Baden, the concretions of which shewed, in addition to the shells, longitudinal striæ—and chambers were visible in the cross section; so that the structure opposed the supposition of a mere calcareous deposition. The same structure was seen in the Meloniæ from the mountain limestone of Lake Onega in Russia; and, by means of sections, distinct views of the structure of the Meloniæ were also obtained, in a piece of hornstone from the mountain limestone of Tula, to which a Spirifer remained adhering, and which was crowded with various Polythalamian forms.

Ehrenberg states that, in many cases, "the Melonias of the oolitic limestone are so changed into calc-spar, that the shells are no longer divided. In other cases there is found in their interior a small kernel of calc-spar, which might easily lead to the supposition that a real incrustation of a grain of sea-weed had taken place, while it is in fact only the internal commencement of the change to crystalline calcareous-spar, as may be recognised by the shining lustre."

The author states, the microscopic organisms from Australia and New Holland present less peculiarity than was expected, in consequence of the remarkable forms of the larger animals of those regions. Only one peculiar genus, Rhizonotia, was found, and all the forms belonged to well-known orders, classes, and families.

The following are the general results from all these examinations:—

"1. Microscopic life, particularly in the forms which constitute masses of earth and rock, appears to exist in the same manner over the surface of the whole earth.

"2. The results already obtained by direct examinations have proved, that in all zones of the surface of the earth, in all climates, in low situations, and the bottom of the ocean, as well as on high mountains, at the elevation of about nine thousand feet, (Niglherri, Mexico,) and even in the smallest particles of humus, microscopic life has not merely an existence, but is in exuberant abundance.

"3. The European microscopic organisms have been shewn to be so related to those of other parts of the earth, that new orders, classes, and families, are nowhere found; but the forms all belong to the generally siliceous, never calcareous shelled Polygastric infusoria, and to the non-siliceous, but generally calcareous shelled Polythalmia, which are not infusoria.

"4. Besides these independent microscopic forms of life, there also are found in soil and in calcareous strata all over the earth, astonishing numbers of small undecomposed regular parts of larger organisms, which are either siliceous or calcareous, and both of vegetable and animal origin, which everywhere present the closest resemblance in characters, however different may be the Flora or Fauna of the localities.

"5. In place of orders, classes, or families, peculiar to different parts of the world, there occur peculiar local genera; which, however, are nowhere numerous; while, on the contrary, there are very numerous peculiar species of widely distributed genera.

"6. Certain geographical latitudes have their characteristic forms of minute animal life. Thus the proportionally large and slender serrated species of Eunotia—*E. tetraodon*, *pentodon*, *diadema*, *serrulata*, &c.—have hitherto been found only in Sweden, Finland, and in North America, from New York to Labrador. Similar species of the broad and small many-toothed species of *Himantidium* and *Eunotia* only occur on the north coast of Asia, at Senegal in Africa, and in Cayenne in South America. The genus *Tetragramma* is found only in Libya and in the Ladrone Isles, and the same species occurs at both places.

"7. There is distributed over all parts of the earth a considerable number of perfectly identical forms, among which are (*Navicula*), *Pinnularia viridis*, *Himantidium arcus*, and *Eunotia amphioxys*. These common forms appear to be the most important in their relations to the economy of nature.

"8. The so-called inorganic constituents of the body, and shells of animalcules, are chiefly carbon, silica, lime, and iron, with traces of alumina and manganese; magnesia and other substances are probably only present as mechanical mixtures.

"9. The quantity of iron in the minutest organisms is sometimes surprisingly great. It is never united with the lime, but only with the silica, appearing to be rather mechanically than chemically combined, and sometimes it seems to exist in a very peculiar, colourless, and chemically inexplicable state. This mechanical union of iron and silica appear to be chiefly an organic deposition of the metal in closed siliceous cells.

"10. In consequence of the uniform and extensive development of minute organic life, it must exert a great and important influence upon other conditions of the surface of the earth, and particularly upon the formation of humus in the valleys of rivers. If the larger organic bodies have direct relations to the condition of the atmosphere, the widely extended and immensely developed minuter forms cannot be without a great influence on those relations.

"11. But the evidence of the influence of microscopic life is not confined to the surface of the earth. The same incomprehensible formation of rocks from the siliceous or calcareous shells of animalcules which is seen in the chalk formation of Europe, occurs also on a gigantic scale both in the north-east and north-west of Africa (Egypt, Oran). It occurs in the north-west of Asia (Bir Hamam, Ante-Libanus, Libanus), and, according to recent observations, in perhaps still greater development in North America (Mississippi, Missouri, New Jersey). The Jura limestones of Europe also shew generally, and sometimes quite distinctly, an intimate connection with organic life; and the very ancient limestones, and included calcedony, said to occur directly beneath the coal at Lakes Tula and Onega in Russia, occasionally shew quite distinctly, that microscopic life had as extensive development in that ancient epoch as at any more recent period. Rocky masses of infusoria are presented by the polishing slates of Lucon and Caucasus; and extensive earthy beds of siliceous infusoria occur, not only in the edible clay of the Amazon, and the very extensive (fifteen to twenty feet thick) infusorial strata of Richmond, Virginia, mentioned by Rogers and Bailey, but also in the siliceous marl (Kieselguhr) in Siberia, and near Perth in New Holland.

"12. Finally, microscopic life is demonstrated to be a most important agent in the formation of the surface of the earth."—J. W. B., *American Journal of Science and Arts*, vol. xlvii., No. I.—July 1844, p. 208.

7. *Land-Slip in the State of Vermont in North America.*—On the evening of Thursday last, one of the most extraordinary land-slips took place which has occurred within the memory of man. The neighbourhood of Lebanon, State of Vermont, was the scene of this remarkable natural phenomenon. The following are the particulars, as described by an eye-witness of the event:—About three miles to the eastward of the village is a high conical hill—I should almost say mountain—rising perpendicularly on its southern side, but on the north sloping gradually from the summit to the rich table-land below. This hill forms part of the property of Benjamin Wurtle, Esq.; and the land around it is divided into three farms, each of which runs in a rectangular shape into the hill, meeting together in a point at its apex. These farms are occupied by tenants—rather an unusual thing in Vermont; and, considering the progress of agriculture in the district, are in a superior state of cultivation. With one of the tenants, Robert Gourlay, I had occasion to transact some business on Thursday last; and having called on him at his farm-house about two o'clock of the day, I was detained till late in the evening. About half-past ten o'clock, as we were in the act of reading over some papers preparatory to their being signed by us, we were started by a sudden explosion. Our first impression was, that a piece of artillery had been discharged in the rear of the farm-buildings; but after reflecting on the exceeding improbability of such an event, we referred the detonation to an earthquake, or some subterranean convulsion. For the next few minutes we sat in a state of considerable alarm, which was a good deal augmented on hearing unusual sounds from the byres and stables, as if the cattle were struggling to get loose. Just as we started from our seats, by a sort of instinctive resolve to ascertain the cause of this singular occurrence, we suddenly felt the house in motion. At first it was a violent jerk, then a movement onwards, not unlike the first starting of a ponderous railway-train. Gradually the motion increased, until we felt ourselves moving along at a rapidly accelerating rate. It was a clear starry night, and I could see the boughs of the trees in the distance passing the windows, just as we perceive the transit of similar objects from the windows of a travelling vehicle. This continued for two or three minutes; and then there was a sudden stop, producing another violent jerk, which threw my friend and me to the opposite end of the room. We ran immediately to the door, and our astonishment may be more easily conceived than described,

on discovering ourselves in an entirely new locality. I saw at once that a land-slip had taken place; but although I have read of similar occurrences in the districts around the Alps, I was not prepared for so remarkable an instance as had just taken place. We found ourselves at least a quarter of a mile from the original spot. The farm-house and out-buildings were all entire. A range of poplars which grew in the neighbourhood of the barn, still occupied the same relative position to that building. The only change observable was, that a stream which flowed a little below the farm-houses had entirely disappeared. The most singular result of this movement is, that the farm-offices of my friend Mr Gourlay are no longer on his own farm. They have been projected upon the lands of a totally different proprietor; and it is supposed, that, unless he manage to rent, in addition to his old farm, the portion of land on which his steading is now located, a good deal of nice litigation will be the consequence of this sudden and unexpected event.—*Montreal Times.*

MINERALOGY.

8. *Chrome in Magnetic Iron Ore.*—Kersten has detected traces of chrome in the magnetic iron ore of *Seegen Mutter Gottes*, near Altenberg, in Saxony.—(*Erdm. und March. Journ.* xxxi. 106; and *Leonhard and Bronn's Jahrbuch*, 1845, Heft 2, p. 199.)

9. *Identity of Chrysotile and Baltimorite.*—Rammelsberg has shewn that the chrysotile of Kobell, which was first described by that mineralogist under the name of Schiller-asbestus from Reichenstein, and which is distinguished by its metallic-pearly lustre, is identical with the Baltimorite of Thomson. As the latter was described subsequently to the former, the name of Baltimorite must be given up. The following are the comparative analyses:—

	Kobell.	Thomson.
Silica,	43·50	40·95
Magnesia,	40·00	34·70
Protoxide of Iron,	2·08	10·05
Alumina,	0·40	1·50
Water,	13·80	12·60
	99·78	99·80

—*Poggendorff's Annals*, vol. lxii. p. 137.

10. *Occurrence of Native Copper, Native Silver, and large veins of Datolite, on the Southern Coast of Lake Superior.*—At the meeting of the Academy of Sciences of Paris, of the 3d March 1845, M. Elie de Beaumont communicated a letter from Dr Jackson of Boston, which contains an account of the occurrence of native copper and native silver on the shores of Lake Superior. At Point Keweenaw, on the southern coast of that lake, copper generally occurs in the metallic state, filling the cavities of an amygdaloidal trap, which forms very thick dikes, traversing beds of old red sandstone and

conglomerate. The copper is sometimes pure, and sometimes mixed with silver; silver occurs in spiculæ and grains, imbedded in the copper, or crystallized in angular globules, adhering to the surface of the mixture of copper and silver. Veins of pure silver traverse masses of copper containing not more than from $\frac{1}{1000}$ to $\frac{3}{1000}$ of combined silver, and would thus seem to have been formed by segregation. Metallic silver is abundantly disseminated in the amygdaloidal rock in grains, which are sometimes as large as peas. Among the curious features of the amygdaloidal trap in question, may be mentioned the occurrence of large veins of datolite, three feet in thickness, in which the crystals of datolite contain small scales of pure copper. Veins of prehnite, three or four feet thick, are also met with in the trap, and these likewise contain numerous spiculæ and scales of pure copper. An erratic block of copper, weighing about three thousand pounds, was found, on conglomerate, near the river Ontonagon, and was probably derived from the serpentine of the *Ile Royale*, which is situated about forty miles to the north.—(*L'Institut*, No. 584.)

11. *Cubane.*—This mineral was first distinguished by Breithaupt (*Pogg. Ann.* 59, p. 353). It has a metallic *lustre*, and its *colour* varies from white to brass yellow; its *streak* is black; the *cleavage* cubic and pretty distinct; the *fracture* flat conchoidal, or uneven; *hardness* equal to that of fluor-spar; *brittle; specific gravity* = 4·026 to 4·042. Before the blowpipe it fuses easily. The cubane has been lately analysed by Scheidhauer (*Poggendorff's Annals*, vol. lxiv., p. 280), and the following is its composition:—

Sulphur, ...	34·78
Iron, ...	42·51
Copper, ...	22·96
Lead, ...	trace
	100·25

The locality of this mineral (which was originally obtained, by way of London, from the island of Cuba) is now ascertained to be Bacuranao, about seven English miles from the Havannah.

12. *Diamonds in the Matrix from Brazil; and Black Diamond, of unusual hardness, from Borneo.*—Lomonosoff has informed the French Academy of Sciences, that diamonds occur in the fixed rock in the so-called Itacolumite of Brazil, on the left bank of the Corsego des Bois, on the Serra da Grammagoa, forty-three Portuguese miles to the north of the town of Tijucco or Diamantina. Diamonds have been obtained there, for some years, by blasting the rock, then breaking it to pieces, and washing it. Several undoubted specimens of diamond in the matrix, brought home by Lomonosoff, were exhibited to the Academy. At the same time, a black mineral was shewn, which Diard had obtained in Borneo, and which is harder than diamond. At the request of the Academy, a skilful lapidary endeavoured to cut it; but, after twenty-four hours'

labour, during which his wheel was much injured, he did not succeed in grinding a single one of the angles presented by the surface. Dumas expressed the opinion, that it may be a so-called *diamant de nature*, by which is meant one of the dull diamonds, exhibiting no cleavage, which, when reduced to powder, are employed in cutting the diamond. These, however, are not black, and it would be an interesting circumstance if the substance in question should prove to be a diamond, which has retained the opacity and black colour of coal.—*Berzelius' Jahres-Bericht, 24th year*, p. 295.

13. *Formation of Iron-Glance by sublimation.*—Mitscherlich's theory of the formation of iron-glance in the fissures and clefts of volcanic mountain-rocks, by the aid of chlorine, is well supported by a phenomenon which has taken place in the salt-mines of Wieliczka. It has sometimes happened that the extensive wood-work of these vast mines has been destroyed by fire; and the iron-work and implements have at the same time suffered. Von Hrdina, one of the officers of the mines, shewed me specimens of saliferous clay, obtained from the vicinity of such conflagrations, in which the fissures were lined and impregnated with iron-glance. A recent formation of iron-glance has thus evidently taken place, in which chlorine must have performed a part.—*Professor Nöggerath, in Karsten's Archiv*, vol. xviii., p. 538.

14. *Greenovite proved to be a variety of Sphene.*—In vol. xxxix. p. 183. of this Journal, we noticed the substance termed Greenovite by M. Dufrénoy. Subsequently, Breithaupt expressed an opinion, founded on external characters, that this mineral was a sphene in which the lime was replaced by the protoxide of manganese. In No. 106 of the *Bibliothèque Universelle de Genève*, we find two papers on Greenovite, the one by M. Achille Delesse, and the other by Professor Marignac; and both authors regard this substance as identical with sphene. M. Delesse mentions, that he received a specimen from M. Dufrénoy, which enabled him to make a more satisfactory analysis than it had been possible for M. Cacarrié to perform at first with the small quantity at that time obtained. The specific gravity, as determined by M. Delesse, is 3·483, a number intermediate between that given by M. Dufrénoy, viz. 8·44, and that given by Breithaupt, viz. 3·527. After carefully separating the veins of quartz which traverse the crystals of Greenovite, and are also interposed between the cleavage faces; and after employing all other possible precautions, M. Delesse obtained the following results from two analyses:—

	I.	Oxygen.	II.	Oxygen.
Silica,	0·298	0·1548	0·304	0·1579
Oxide of Titanium,	0·430	0·1707	0.420	0·1668
Protoxide of Manganese,	0·029	0·0728	0·038	0·0768
Protoxide of Iron,	trace		trace	
Lime,	0·236		0·243	
	0·993		1·005	

From these analyses M. Delesse deduces the following formula:— Si O^3, 3 Ti O^2 + Si O^3, 3 (CaO, MnO), which corresponds exactly with the formula given by Henry Rose for sphene. Professor Marignac also analysed the Greenovite, and obtained nearly the same results, with the exception, that he found a larger quantity of lime, and a smaller proportion of the oxide of manganese; but, as these bases are isomorphous, their relative proportions may vary in different specimens. Professor Marignac states that, along with M. Descloizeaux, he obtained a considerable number of specimens of Greenovite at Saint-Marcel, near Aoste, and that the examination of its crystals has convinced him that all the forms can be referred to those of sphene. This conviction has been confirmed by the discovery of a crystal of sphene from St Gothard, which accidentally presented cleavage faces parallel to the faces of the ordinary prism of the Greenovite. M.M. Dufrénoy and Descloizeaux are about to publish a description of the crystallographic forms of Greenovite.

15. *Magnesian Apatite, a New Mineral described by Hermann.*—It occurs near Kusiusk, in the Schischimian Mountains, in a vein traversing chlorite slate, and is associated with crystallized chlorite (Leuchtenbergite), apatite, chlorospinel, and magnetic iron ore. It is always crystallized in regular six-sided prisms, which are from a few lines to several inches in length, but are of comparatively small diameter. The crystals are arranged in stellular or irregular groups. There is no trace of cleavage planes; but still the crystals are fissured in a direction perpendicular to the principal axis. Externally the mineral is generally weathered, and is dull, earthy-looking, and yellowish; on the fresh splintery fracture, however, it is milk-white, and translucent on the edges. The hardness = that of apatite. The specific gravity from 2·70 to 2·75. Its characters before the blowpipe are like those of apatite. The following is the analysis:—

Lime,	37·50
Magnesia,	7·74
Phosphoric Acid,	39·02
Sulphuric Acid,	2·10
Chlorine,	0·91
Oxide of Iron,	1·00
Fluorine and loss,	2·23
Insoluble,	9·50
	100·00

As the magnesian apatite is very similar in colour, structure, &c. to the phosphorite of Estremadura, the latter was examined for magnesia, but no trace of it could be found.—(*Erdm. und March. Journ.* xxxi. 101; and *Leonhard und Bronn's Jahrbuch*, 1844, Heft 6, p. 720.)

16. *Identity of Mellilite and Humboldtilite.*—The analyses of Damour have proved that these two substances belong to one and

the same mineral species. The *mellilite* occurs in the basaltic rocks of the neighbourhood of Rome, and chiefly in the quarries of Capo di Bove; sometimes in the form of imbedded grains, and sometimes as crystals lining drusy cavities and fissures. It is associated with augite, nepheline, Breislakite, calcareous spar, and a capillary mineral, which has not as yet been properly examined. Its *colour* is honey-yellow and dark brown; it is *semitransparent;* its *fracture* is conchoidal, with a vitreous shining *lustre;* the *crystals* are rectangular four-sided prisms, and are never more than a line in diameter. It *scratches glass* feebly; and its *specific gravity* is 2·95. The following is its *chemical composition* :—

	Honey-yellow Crystals.	Brown Crystals.
Silica, ...	39·27	38·34
Lime, ...	32·47	32·05
Magnesia, ...	6·44	6·71
Potash, ...	1·46	1·51
Soda, ...	1·95	2·12
Oxide of Iron, . . .	10·17	10·02
Alumina, ...	6·42	8·61
Oxide of Manganese, . .	...	trace.
	98·18	99·36

The *Humboldtilite* occurs in the blocks of Monte Somma, and has the same crystallographic form as the mellilite. It is associated with black augite crystals, is of a light-yellow *colour*, and in its other characters is similar to mellilite. Its *specific gravity* is 2·90; and its crystals, which are generally coated with a thin earthy covering of lime, and are larger than those of the mellilite, afford traces of *cleavage* in the direction of the terminal plains. The following is the result of M. Dumour's analysis :—

Silica, ...	40·69
Lime, ...	31·81
Magnesia, ...	5·75
Potash, ...	0·36
Soda, ...	4·43
Oxide of Iron, ...	10·88
Alumina, ...	4·43
	98·35

It is proposed by M. Dumour to unite these two substances under the name of Humboldtilite.—(*Ann. de Chim. et de Phys.;* and *Leonhard und Bronn's Jahrbuch*, 1844, Heft 5, p. 592.)

17. *New Analysis of Perowskite.*—This mineral, which was first described by Professor G. Rose, and which we formerly noticed in vol. xxix., p. 418 of this Journal, has now been fully analysed in the laboratory of Professor Henry Rose, by Dr Jacobson, and by Mr Brooks of Manchester. The following is its composition, as determined by the latter gentleman :—

		Oxygen.
Titanic acid, ...	59·00	23·43
Lime, ...	36·76	10·16
Protoxide of iron, with slight traces of protoxide of Manganese, . . .	4·79	1·09
Magnesia, ...	0·11	0·04
	100.66	

—*Poggendorff's Annalen*, vol. lxii. p. 598.

18. *Polykrase and Malakone, two New Mineral Species.*—In a Memoir on the Norite of Hitteröe,* contained in the second part of Keilhau's *Gaea Norvegica*, Scheerer describes, under the above names, two new substances, detected by him in the granite veins which traverse the norite. Both are generally associated with orthite, and are often accompanied by Yttria-spar or phosphate of Yttria; and they are not unfrequently to be observed mixed with the former. This is probably the cause of small quantities of titanic acid and zirconia being sometimes detected in the orthite of Hitteröe; for they undoubtedly do not belong to that mineral, but may have been derived partly from the polykrase, and partly (the zirconia) from the malakone. The *polykrase* (derived from πολυ and κρασις) is nearly related to the polymignite, but still differs from it in many respects. Its crystals are sometimes 1 or 1½ inches in length, and belong to the rhombic system. The relations of the axes cannot, however, be deduced from those of the polymignite. There is no indication of cleavage, and the *fracture* is conchoidal. The *hardness* cannot be determined with exactness, as the crystals are very easily frangible; but it appears to be less than that of the polymignite. The *specific gravity* = 5·105. The *colour* is pure black, but thin splinters are translucent, and have a yellowish-brown colour. The *streak* is greyish-brown. The *lustre* is less considerable than that of polymignite. A qualitative analysis of polykrase afforded the following constituents:—Titanic acid, Tantalic acid, Zirconia, Yttria, Oxide of Iron, Oxide of Uranium, Protoxide of Cerium, together with a small quantity of Alumina, and traces of Lime, Magnesia, and perhaps an Alkali. The constituents of polymignite are, according to Berzelius, Titanic acid (46·30), Zirconia (14·14), Oxide of Iron (12·20), Lime (4·20), Protoxide of Manganese (2·70), Protoxide of Cerium (5·0), Yttria (11·50.) We have, therefore, the following differences in the composition of the two minerals:—1, The presence of Tantalic acid and Oxide of Uranium in polykrase; and, 2, the absence of Protoxide of Manganese, and the almost total absence of Lime in that mineral. The *malakone* (from μαλακος) is so called from its possessing an inferior degree of hardness to the zircon, a mineral with which it has very considerable analogy. Its *crystallo-*

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* The Island of Hitteröe is also a locality of Gadolinite, and is situated on the south coast of Norway, about twenty-three English miles to the north-west of Cape Lindesnäs.

graphic form is similar to that of the zircon, but not identical. It presents no distinct cleavage, and the *fracture* is small conchoidal. The *hardness* is that of felspar, and it is, of course, easily scratched by zircon. The *specific gravity* = 3·903, while that of zircon = 4·4 to 4·6. *Colour*, bluish-white; but that of the surface of the crystals is generally rendered brownish, reddish, yellowish, or blackish, by a thin coating of foreign substances. The *lustre* of the crystalline faces is vitreous, but feebler than in zircon; and that of the fractured surface is resinous. In small fragments it is translucent, with a yellowish-white colour. The *streak* is colourless. The following is the result of a quantitative analysis:—

Silica,	31·31
Zirconia,	63·40
Oxide of Iron,	0·41
Yttria,	0·34
Lime,	0·39
Magnesia,	0·11
Water,	3·03
	98·99

It may be assumed that only the silica, zirconia, and perhaps the water, are essential constituents of malakone. The substance might thus be regarded as a zircon containing water, which, on being heated, becomes converted into ordinary zircon, after losing its water, and after exhibiting, to a certain extent, the pyrognomic property presented in a greater degree by gadolinite and polykrase. Scheerer considers it as probable, however, that the zirconia exists in malakone in a different isomeric condition from the zirconia in zircon; and that, after being exposed to heat, it passes, with evolution of light, into the same modification in which it is contained in zircon. Perhaps the different isomeric condition of the zirconia is the only essential difference between zircon and malakone; and this is rendered the more probable, as, according to Scheerer, no true hydrate is known which contains so small a quantity of water as the malakone, and as there are several other minerals in which a variable quantity of water disappears on the application of heat. This is the case, for instance, with some gadolinites, orthites, and elaolites.

19. *Simondine, a New Mineral Species.*—B. de Lom has found a mineral at Saint Marcel, which has been described and analysed by Delesse, and has received its name in honour of the mineralogist Sismonda. It occurs in chlorite slate, and is associated with garnets, titanic iron, and iron pyrites—*colour*, dark green; *streak*, light greenish-grey; *scratches glass*; *specific gravity* = 3·565; crystallographic form not yet determined; distinct *cleavage* in one direction; a considerable *lustre*; *fracture* uneven. Its *chemical composition* is the following:—

Silica, ...	24·1
Alumina, ...	43·2
Protoxide of Iron, ...	23·8
Oxide of Titanium, ...	trace.
Water, ...	7·6
	98·7

—*Ann. de Ch. et de Phys.* ix. 385; and *Berzelius' Bericht*, xxiv. p. 284.

20. *Spadaite, a New Mineral.*—Von Kobell has examined and described a new mineral from Capo di Bove, which he has named Spadaite in honour of Monsigre. de Medici Spada, from whom he obtained it. This substance forms small compact masses, which are intermixed with Wollastonite. Its *fracture* is imperfectly conchoidal and splintery; the *colour* reddish or flesh-red; *streak* white; it is *transparent;* the *lustre* is glistening or glimmering, and resinous; *hardness* = 2·5. It is soluble in muriatic acid, with a residuum of gelatinous silica; and it is composed of silica, magnesia, protoxide of iron, alumina, and water. The formula is $M\,Aq^4 + 4\,M\,S^3$. The following is an interesting comparison, given by Von Kobell, of the combinations of silicate of magnesia and hydrate of magnesia:—

Picrosmine, . .	$2\,MS^2 + Aq.$
Picrophylle, . .	$3\,MS^2 + 2\,Aq.$
Aphrodite, . .	$MS^2 + 3\,Aq.$
Villarsite, . . .	$4\,MS + Aq.$
Dermatine, . .	$Ma^2S^3 + 4\,Aq(?)$
Meerschaum, . .	$MS^3 + 2\,Aq.$
Nemalite, . . .	$MS + 2\,MAq.$
Serpentine, . .	$2\,MS^2 + MAq(?)$
Hydrophite, . .	$2\,MS^2 + MAq^3.$
Antigorite, . .	$3\,MS^2 + MAq.$
Chrysotile,* . .	$3\,MS^2 + MAq^3.$
Schillerspar, . .	$4\,MS^2 + MAq^4.$
Spadaite, . . .	$4\,MS^3 + MAq^4.$

—*From Berzelius' Jahres-Bericht, 24th Jahrgang*, p. 281.

21. *Sulpho-Arseniuret of Lead, a New Mineral Species.*—On the 14th April 1845, M. Dufrénoy read to the Academy of Sciences of Paris a notice by M. A. Damour, on the crystallized sulpho-arseniuret of lead from Saint-Gothard, a new mineral species, which seems to have been hitherto confounded with grey copper. It is found in granular dolomite, and is principally composed of sulphur, arsenic, and lead, but also contains slight traces of copper and silver. The following is its chemical constitution:—

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* Or Schiller-asbestus from Reichenstein, a substance which, as it does not belong to what is generally understood under the name of asbestus, has been termed chrysotile, from χρυσος gold, and τιλος wire.

Sulphur,	22·18
Arsenic,	20·33
Lead,	57·09
	99·60

This substance is analogous, in the proportions of its component parts, to the *Federerz*, from Wolfsberg in the Harz, analysed by Henry Rose; but the latter is a sulpho-*antimoniuret* of lead, (*L'Institut, No.* 590.)

22. *Scheerer on the Sunstone, and on the Microscopic Examination of various other Minerals.*—The sunstone, or avanturine-felspar, was formerly found exclusively in the vicinity of Archangel, and more particularly on the island of Cedlovatoi. It was afterwards met with in Ceylon, and has been lately brought by Fiedler from the neighbourhood of Lake Baikal. About a year ago Mr Weibye made the interesting discovery, that avanturine-felspar, of great beauty, occurs near the town of Tvedestrand, on the Christiania-fjord.* This caused Scheerer to undertake a more minute examination of the substance. It has hitherto been supposed that the peculiar glittering reflection of light, which it exhibits when turned in particular directions, proceeds either from extremely fine fissures in its interior, or from small imbedded plates of mica. A microscopical and chemical investigation has proved to Scheerer that this is not the case, and that the play of light in the avanturine-felspar proceeds from small lamellar crystals of iron-glance, which are disseminated through its mass. Our space does not permit us to give the interesting details communicated by Scheerer regarding the microscopic structure of the sunstone and other minerals, but we extract the following general results of his investigations. 1. Certain felspars contain microscopic crystals of iron-glance, and probably sometimes of titanic iron, which are imbedded in a regular manner in their mass. The relative proportion by weight of the interposed mineral is small, and scarcely exceeds from one-half to one per cent. This small quantity, however, is sufficient to produce the beautiful play of light and of colours in the sunstone. 2. Hypersthene, bronzite, diallage, and anthophyllite, from various localities, contain numerous lamellæ of an interposed dark coloured body, which, doubtless, give rise to the peculiar metallic lustre of these minerals; a lustre more especially visible on the most distinct cleavage-faces. The relative proportion by weight of the interposed body may amount, in many cases, to several per cent. 3. The colour of the coloured felspars frequently proceeds from disseminated pulverulent bodies, whose relative proportion by weight seems, for the most part, to be inconsiderable.—It further results, that the chemical analysis of the minerals included under 2, cannot afford perfectly

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* Small portions of sunstone were also found some years ago by Scheerer, in the island of Hitteröe, as stated in the second part of the Gaea Norvegica, p. 323. The felspar of the sunstone from this locality, as well as of that from Tvedestrand, is an oligoclase, but this is not always the case with the sunstone from other places.

correct conclusions as to their true composition. Before analysing such substances, a microscopical examination should never be omitted. The microscope, however, may also deceive us, for it can by no means be asserted, that all the interposed bodies which are imbedded in a transparent mineral are invariably darker in colour than the mass of the latter. With respect to opaque minerals, the microscope is of course useless. Many variations, of greater or less amount, which occur in exact analyses of one and the same mineral, are undoubtedly caused by the presence of interposed bodies. This much, however, appears to be proved, that it is chiefly those minerals only, which are remarkable for distinct cleavage planes, that are liable to this intermixture with foreign matters.—(*Poggendorff's Annals*, vol. lxiv. pp. 153–169.)

23. *Tenorite, a New Mineral Species.*—This name has been given by Semmola to a newly distinguished substance, in honour of Tenore, the president of the Neapolitan Academy of Sciences. It is pure crystallized oxide of copper, and occurs not unfrequently in the smaller crater-openings of Vesuvius, more particularly in that of the year 1760. It is found in long hexagonal, triangular, or irregular scales, which have a metallic *lustre*, and a *colour* varying from steel grey to black; and which are from one-twentieth to one-third of an inch in diameter. The *streak* is black. It is soluble with effervescence in acids, and conducts itself before the blowpipe like pure oxide of copper.—(*Berzelius' Jahres-Bericht, 24th year*, p. 282; and *Opere Minori di Giovanni Semmola*, p. 45.)

24. *Thomäite, a New Mineral Species.*—Mayer describes under this name, a carbonate of iron found in 1843, at the Bleis-Bach, near the *Scheurener Steeg*, in the Siebengebirge, and which, although undoubtedly belonging to the genus Sphærosiderite, does not resemble any of the known species. When first obtained from the clay in which it forms a stratum, this iron ore is of bluish colour, moist, and so soft that the largest pieces crumble in the hand. After it has been exposed for two days to the open air, the colour changes to a pale honey yellow, and the mineral becomes perfectly dry and compact. The Thomäite, so named in honour of Professor Thomä of Wiesbaden, presents the following oryctognostical characters: the *crystals* are rectangular octahedrons, which are composed of individual crystals and grains; *fracture*, large granular; *lustre* on the fresh surfaces pearly; *specific gravity* = 3·10; *streak* white. The analysis afforded

Protoxide of iron,	53·72
Silica,	6·04
Alumina,	4·25
Lime,	1·52
Magnesia,	0·43
Protoxide of manganese,	0·65
Carbonic acid,	33·39
	100·00

The Thomäite approaches pretty nearly the Junkerite, and the crystallographic form is the same; but the great distinction between the two minerals consists in the very peculiar crystalline-granular constitution of the Thomäite; besides the difference in specific gravity, fracture, colour, &c.—(*Leonhard's Jahrbuch*, 1845, Heft 2, p. 200.)

25. *Analysis of Tschewkinite.*—We formerly published an account of this remarkable mineral in vol. xxix., p. 418, of this Journal. The Tschewkinite was first made known by Gustav Rose; and Henry Rose has lately published, in Poggendorff's Annals (vol. lxii., p. 592) the following more complete analysis, which is the mean of not less than six distinct analyses:—

Silica,	21·04
Lime,	3·50
Magnesia,	0·22
Protoxide of manganese,	0·83
Potash, Soda,	0·12
Oxide of cerium Oxide of lantanium, Oxide of didymium,	47·29
Protoxide of iron,	11·21
Titanic acid,	20·17
	104·38

The excess in the analysis arises from the oxide of cerium existing in the mineral in the form of protoxide. Complicated as the composition of Tschewkinite is according to the above analysis, there still appear to be minute portions of other constituents; for Professor Henry Rose detected a slight trace of yttria, and what seemed to him slight traces of glucina and alumina.

26. *Vanadium-Bronzite.*—Schafhäutl has described and analysed a bronzite containing vanadium, from the steatitic rocks of Bracco, on the Genoese coast. It is large-foliated, with one distinct and two indistinct cleavages; has a pearly lustre, is translucent in thin fragments, is of a greenish-grey colour, scarcely so hard as fluor-spar, and easily frangible. Specific gravity = 3·255. Its composition is nearly the same as that of the bronzite of Salzburg, except that a portion of the oxide of iron of the latter is replaced by oxide of Vanadium and soda.—(*L'Institut*, *No.* 589.)

27. *Variety of Xanthokone resembling Greenockite.*—Breithaupt formerly described in Erdmann's Journal (vol. xx., p. 67) a mineral which had been found, in the year 1797, in the celebrated mine of Himmelsfürst, at Erbisdorf, near Freiberg, and which he named xanthokone, on account of its yellow streak. During a visit to the same mine in October 1844, Breithaupt found crystals of this mineral imbedded in calcareous spar, and presenting a great resemblance to Greenockite. The *crystals* are very thin hexagonal tables; the

lustre adamantine; *colour* orange yellow; *streak* between orange-yellow and yellowish-brown; *transparent* to *translucent;* easily frangible, and somewhat brittle; *hardness* = 2½ to 3½; specific gravity, 5·158 to 5·191. The following are the component parts (as determined by the analyses of Professor Plattner) of the brown xanthokone formerly found, and the yellow xanthokone now discovered:—

	Brown Xanthokone.	Yellow Xanthokone.
Silver, . .	64·181 . .	63·880
Sulphur, . .	21·358 . .	21.798
Arsenic, . .	13·491 . .	14·322
Iron, . .	0·970 . .	0·0
	100·	100·

It thus appears that, notwithstanding the great similarity of the yellow xanthokone to Greenockite in external appearance, the composition of the two minerals is widely different.—(*Poggendorff's Annals*, vol. lxiv., p. 272 and 275.)

28. *Occurrence of the Silicates of Yttria and the Protoxide of Cerium in the Saxon Erzgebirge.*—While occupied with an investigation of the felspars of the Erzgebirge, Carl Kersten analysed the substance termed oligoclase by Breithaupt, from Boden, near Marienberg, chiefly on account of its great resemblance to the natron-spodumene from the granite near Stockholm. In some fragments of this kind of felspar there were small blackish-brown disseminated portions, in which preliminary experiments indicated the presence of a considerable quantity of the protoxide of cerium. Subsequently, Kersten obtained a larger quantity of the disseminated mineral; and, upon a more minute examination, he ascertained that the blackish-brown portions are composed of two distinct substances, of which the one approaches most nearly the Allanite of the Jotun-Fjeld, and the second the orthite of Ytterby. As, however, the Allanite and orthite appear, from the investigations of Scheerer, to be nearly allied, perhaps the two minerals from the Erzgebirge may prove to be varieties of one species; but this can only be determined by quantitative analyses.—(*Leonhard and Bronn's Jahrbuch*, 1845, Heft 2, p. 202, *from Poggendorff's Annalen*, vol. lxiii., p. 135.)

29. *Yttro-Titanite, a New Mineral Species described by Scheerer of Christiania.*—In a quarry about seven English miles to the north-east of Arendal, in Norway, at the southern extremity of the island of Bu (*Buöe*), a considerable quantity of felspar occurs in the gneiss, partly in the form of veins, and partly in irregular masses. Close to the junction with the gneiss, Scheerer found in the felspar the half of a round imbedded fragment, of the size of a fist, of a mineral having the following characters:—One distinct *cleavage*, and feeble traces of two others; *fracture* small conchoidal, passing into uneven; *colour* brownish-black; the *streak* light greyish-brown; *trans-*

lucent, with a brownish-red colour; *lustre* vitreous on the most distinct cleavage faces, and inclining to resinous on the fractured surface; *hardness* between quartz and felspar; *specific gravity* = 3·69. The chemical examination yielded the following constituent parts:—Silica, Titanic acid, Lime, Yttria (from eight to ten per cent.), Oxide of iron, Manganese, Alumina, and Magnesia. Subsequently to Scheerer's investigation of the yttro-titanite, he ascertained that, singularly enough, Axel Erdmann, secretary of mines at Stockholm, had previously obtained the other half of the imbedded mass from the same quarry, and that a qualitative analysis had afforded him identical results.—(*Poggendorff's Annalen*, vol. lxiii. p. 459, and *Leonhard's Jahrbuch*, 1845, Heft 2, p. 203.)

CHEMISTRY AND THE ARTS.

30. ***Ruthenium, a New Metal.***—Professor Claus of Kasan, states, that after two years' uninterrupted labour, he has at last succeeded in obtaining a new metal in a pure state from the platinum residuum; and that he proposes to give it the name of Ruthenium, because it is contained in small quantity in a white body mentioned by Osann, which consists chiefly of silica, titanic acid, oxide of iron, and zirconia, and which the latter chemist considered as a peculiar metallic oxide, and termed Oxide of Ruthenium. Hitherto Professor Claus has only obtained the metal in the form of a blackish-grey powder, which is considerably lighter than iridium. It belongs to the interesting group of the platinum metals, and its chlorides and double chlorides are very similar to those of iridium. The resemblance of the chloride of potassium and iridium to the corresponding salt of the new metal is so great, that Berzelius, to whom a specimen was sent, at first declared it to be a salt of iridium; a week afterwards, however, Professor Claus received a letter from him, in which he retracted that opinion, and stated, that he regarded it as a salt of an unknown metal. According to the discoverer, Ruthenium possesses such distinct and peculiar characters, that no doubt can be entertained of its being a new metal. Professor Osann says, that he had previously detected a metal (*Poggendorff's Annals*, vol. xiv., 1828, p. 349) belonging to the platinum group, which he thinks possesses the same properties as the Ruthenium of Claus, and which he had proposed to term Poline, from πολιος, grey.—(*Poggendorff's Annals*, vol. lxiv., 192 and 208.)*

31. *Occurrence of Chloride and Bromide of Silver in Ancient*

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* Within the last six years, no less than seven new metals have been announced, viz., *Lantanium* and *Didymium* (which were found associated with cerium), and *Erbium* and *Terbium* (whose oxides occur combined with Yttria), discovered by Mosander; *Niobium* and *Pelopium* (both in the Tantalite or Columbite of Bavaria), by Professor Henry Rose; and now the *Ruthenium*, by Professor Claus.—Edit.

Coins.—Professor Hausmann has published in Karsten's Archiv (vol. xviii. p. 505), a curious account of the chemical examination of ancient coins, by Mr Brüel of Hanover. The most remarkable result of the investigation is the discovery of chloride and bromide of silver in most of the coins analysed. The largest quantity of these substances was met with in Greek coins, and in Saxon coins of the thirteenth century, but they were also found in Roman coins. Brüel expresses no opinion as to the origin of the chloride and bromide of silver, but seems inclined to the probable belief, that the chlorine and bromine were not originally contained in the coins, but that they were derived from without. In order, however, to elucidate the subject, it would be desirable to analyse ancient coins which had not been buried in the earth.

32. *The economical extraction of Sulphate of Soda from Sea-Water.*—On the 7th October 1844, M. Balard read a paper to the French Academy of Sciences on the means of extracting from sea-water the sulphate of soda, in sufficient quantity for all the purposes of commerce, without having recourse to the present expensive process. Hitherto it has been found impracticable to obtain the sulphate of soda from sea-water in abundance; but M. Balard calculates theoretically, that from an evaporating surface of 200 hectares (about 500 English acres), 2,500,000 kilogrammes might be produced in one year, although practically the amount would not be more than 600,000 kilogrammes. We extract from the paper of M. Balard, a passage shewing the causes which have hitherto prevented such results, and his means of remedy:—"When two salts differ in their acid and their base, a double decomposition is possible, and the presence of one salt may favour the solubility of the other. When two salts have, on the contrary, the same acid or the same base, and the double decomposition is no longer possible, the same phenomenon does not take place. The solubility of one of the salts is diminished by the presence of the other, except in the case of the formation of a double salt. Thus, the hydrochlorate of magnesia impedes the solubility of sea-salt, because it is an hydrochlorate, and that of the sulphate of magnesia, because it is a salt of magnesia. It favours, on the contrary, the solubility of sulphate of soda, because, probably, in this case, the double decomposition takes place. The solubility of the sulphate of soda is, on the contrary, diminished by the presence of sea-salt, because it is a salt of soda. The practical conclusion is simple. Since the hydrochlorate of magnesia impedes the solubility of the sulphate of magnesia and of the sea-salt, between which the decomposition is to be effected; and, on the contrary, favours the solubility of the sulphate of soda which is to be precipitated, it must be removed. Since, on the other hand, sea-salt impedes the solubility of sulphate of soda, and favours the precipitation of the product to be isolated, it must be added. To extract from the mother-water the sulphate of magnesia, to eliminate the chloride

of magnesium, and to add sea-salt in excess—such is the process to be carried on." M. Balard adds, that the sulphate of soda thus obtained is hydrated, but pure; it does not contain sulphate of magnesia, and is free from the excess of acid and the proportion of iron which are frequently found in the sulphate of soda of commerce.—(*L'Institut*, No. 563.)

33. *Liquefaction of Nitrous Oxide.—Paris Academy of Sciences*, Nov. 18. 1844.—A communication was read from M. Natterer jun., of Vienna. When, several years ago, M. Thilorier succeeded in liquefying and solidifying carbonic acid gas by means of a pressure estimated at 70 atmospheres, it was generally inferred that there was no gas of any kind, which, by means of intense cold and powerful compression, might not be brought to a liquid state. M. Natterer now informs the Academy, that he had succeeded in liquefying a gas well known to chemists, and, indeed, to the public generally, from its exhilarating properties, which have given to it the name of laughing-gas. He has done this by compressing it with a small iron pump, in a piece of wrought iron, at a pressure of 50 atmospheres. The liquid thus obtained was very sweet and fluid, and occupied about the $\frac{1}{100}$th part of the volume of the gas which furnished it; and he was able to keep it in the liquid state several hours exposed to the external air. If the skin was touched with this liquid it caused intense pain, as from a burn. M. Natterer obtained about half a pint of the liquid, and was therefore able, with such a quantity, to make several experiments.—(*Athenæum*, No. 892, p. 1099.)

34. *Professor Faraday on the Liquefaction and Solidification of Bodies generally existing as Gases.—Royal Society, London, January* 16. 1845—The method employed by the author for examining the capability of gases to assume the liquid or solid form, consisted in combining the condensing powers of mechanical compression with that of very considerable depressions of temperature. The first object was obtained by the successive action of two air-pumps: the first having a piston of one inch in diameter, by which the gas to be condensed was forced into the cylinder of the second pump, the diameter of whose piston was only half an inch. The tubes into which the air, thus further condensed, was made to pass, were of green bottle glass, from one-sixth to one-quarter of an inch in external diameter, and had a curvature at one portion of their length adapted to immersion in a cooling mixture. They were provided with suitable stop-cocks, screws, connecting pieces, and terminal caps, all very carefully made, and rendered sufficiently air-tight to retain their gaseous contents under the circumstances of the experiments, and when they were sustaining a pressure of fifty atmospheres, as ascertained by mercurial gauges connected with the apparatus. Cold was applied to the curved portions of the tube, by their immersion in a bath of Thilorier's mixture of solid carbonic acid and ether. The degree of cold thus produced, when the mix-

ture was surrounded by the air, estimated by an alcohol thermometer, was a temperature of — 106° Fahr. But on placing the mixture under an air-pump, and removing the atmospheric pressure, leaving only that of the vapour of carbonic acid, which amounted only to $\frac{1}{24}$th of the former (that is, to the pressure of a column of 1·2 inch of mercury), the thermometer indicated a temperature of 166° below zero of Fahrenheit's scale. In this state the ether was very fluid, and the bath could be kept in good order for a quarter of an hour at a time.

The author found that there were many gases which, on being subjected to cold of this extreme intensity, condensed into liquids, even without a greater condensation than that arising from the ordinary atmospheric pressure, and that they could then be preserved, sealed up in glass tubes, in this liquid state. Such was the case with chlorine, cyanogen, ammonia, sulphuretted hydrogen, arseniuretted hydrogen, hydroiodic acid, hydrobromic acid, carbonic acid, and euchlorine. With respect to some other gases, such as nitric oxide, fluosilicon, and olefiant gas, it was difficult to retain them for any length of time in the tubes, in consequence of the chemical action they exerted on the cements used in the joinings of caps and other parts of the apparatus. Hydroiodic and hydrobromic acids could be obtained either in the solid or liquid state. Muriatic acid gas did not freeze at the lowest temperature to which it could be subjected. Sulphurous acid froze into transparent and colourless crystals, of greater specific gravity than the liquid out of which they were formed. Sulphuretted hydrogen solidified in masses of confused crystals of a white colour, at a temperature of — 122° Fahr. Euchlorine was easily converted from the gaseous state into a solid crystalline body, which, by a slight increase in temperature, melted into an orange-red fluid. Nitrous oxide was obtained solid at the temperature of the carbonic acid bath *in vacuo*, and then appeared as a beautifully clear and colourless crystalline body. The author conceives, that in this state it might, in certain cases, be substituted with advantage for carbonic acid in frigorific processes, for arriving at degrees of cold far below those hitherto attained by the employment of the latter substance. Ammonia was obtained in the state of solid white crystals, and retained this form at a temperature of — 103°. The following liquids could not be made to freeze at — 166°, namely, chlorine, ether, alcohol, sulphuret of carbon, caoutchoucine, camphine, and rectified oil of turpentine. The following gases shewed no signs of liquefaction when cooled by the carbonic acid bath, even when subjected to great pressure, namely,

Hydrogen and oxygen, at a pressure of . .	27	atmospheres.
Nitrogen and nitric oxide, at a pressure of .	50	...
Carbonic oxide, at a pressure of	40	...
Coal gas, at a pressure of	32	...

ZOOLOGY.

35. *Description, by Captains Cook and Flinders, of Birds' Nests of Enormous Size on the coast of New Holland.* By Professor Edward Hitchcock.—In lecturing on the huge footmarks of sandstone in the Connecticut valley, I have been in the habit, for many years, of reading to my classes, *as the poetry of the subject*, some statements ftom the 12th volume of the Athenæum, or Spirit of the English Magazines, (p. 48), respecting enormously large birds and birds' nests. As some of these statements are manifestly fabulous, it never occurred to me till to-day to inquire whether any of them were true. I was led to make the inquiry, probably, by the astonishing discoveries of Professor Owen, respecting the *danger bird* of New Zealand; and the result is, *that I have almost persuaded myself that, with the help of Captains Cook and Flinders, I have found the nest of the Dinornis on the coast of New Holland.* These navigators have given the following statements in their published voyages. I quote Cook's account from Kerr's collection of Voyages and Travels, vol. xiii., p. 318. It was Cook's first voyage. Lizard Island is near the northeast coast of New Holland, not far from Cape Flattery, and in about 15° S. lat.

"At two in the afternoon," says Cook, "there being no hope of clear weather, we set out from Lizard Island to return to the ship, and in our way landed upon the low sandy island with trees upon it, which we had remarked on our going out. Upon this island we saw an incredible number of birds, chiefly sea-fowl; we found also the nest of an eagle with young ones, which we killed; and the nest of some other bird, we knew not what, of a most enormous size. It was built with sticks upon the ground, and was no less than six-and-twenty feet in circumference, and two feet eight inches high. To this spot we gave the name of Eagle Island," &c.

Captain Flinders found two similar nests on the south coast of New Holland in King George's Bay. Not having his work at hand, I quote from the Quarterly Review for October 1814, his description of these nests.

"They were built upon the ground, from which they rose above two feet, and were of vast circumference and great interior capacity; the branches of trees and other matter of which each nest was composed, being enough to fill a cart."

Now I suppose from the character of Captains Cook and Flinders, we may place implicit confidence in the truth of these accounts. Indeed, Cook was accompanied to Eagle Island by Sir Joseph Banks. Equally certain is it that no known bird but the Dinornis would have built so enormous a nest. I am led, therefore, almost irresistibly, to inquire, whether the Dinornis may not be an inhabitant of the coast of New Holland, and still alive? Even if extinct upon New Zealand, it may have remained longer in the warmer climate of New

Holland. It may be, that these nests have been accocunted for in some other way; but if so, I have seen no other explanation.—*American Journal of Science and Arts*, vol. xlvii., No. 1, July, 1844.—P. 217.

36. *The Human Skull employed as a Drinking Vessel.*—The skull of an Aboriginal of South Australia, transmitted by Governor Grey as an example of the habit of the tribe to convert that part of the human body into a vessel for holding and carrying water, was exhibited by Professor Owen. He explained the mode in which it had been made applicable to this purpose. After removal of the soft parts of the head and the lower jaw, the bones of the face had been broken away, with the partition and roof of the orbits, and the cranial box was then suspended by a neatly plaited net-rope of threads, made of twisted vegetable fibres, passed through the hole made in the roof of the orbits and through the foramen magnum, this suspender being terminated by an ornamental tassel. Leakage by the sutures of the cranium, especially the squamous suture, had been prevented by pitching them over with a native bitumen and cementing pieces of the nacreous lining of shells along the course of the sutures.

The exterior of this specimen of barbarous art was polished, and the processes and other protuberances worn smooth by habitual use: the effects of this were most obvious on the external angular processes of the orbits, which seemed to have served as the spouts of the vessel.

The aborigines of the tribe appear to have practised this art from time immemorial: each *Gin* or wife possesses and usually fabricates her cranial calabash, with which she fetches the domestic supply of water from the pond or river, and suspends it in the hut or on the branch of an adjoining tree. They have no arts of pottery, and nature has not supplied them with vessels from the vegetable kingdom, like those which the cujete or cocoa-nut furnish to more favoured tribes.

The Scandinavian legends tell of the ancient warriors who quaffed their wine from the skulls of their enemies, but Professor Owen believed the present to be the first instance of the habitual conversion of part of the human skeleton into a drinking vessel.

37. *On the Stature of the Guanches, the extinct Inhabitants of the Canary Islands.*—It is well known that prior to the discovery of the Canary Islands by the Spaniards, and their subsequent occupation by the Portuguese, these islands were inhabited by a race of men of which not only many curious particulars are recorded, but individual remains of the people themselves are preserved in their mummies, which, at one period, were very numerous.

By many of the historians who have written of these people, either from personal observation, or so soon after the conquest that authentic information must have been readily accessible to them, the

Guanches are described as remarkable for their stature, their extraordinary agility and their great strength. Dr Prichard, in his laborious and admirable work, has, in speaking of the Guanches, adopted this description, and Sabin Berthelot, who has written an interesting article on this people, which is published in the "Transactions of the Ethnological Society of Paris," has mentioned authorities and quoted remarkable passages which describe the ancient inhabitants of the Canaries as possessing the qualities just mentioned.

The casual observation of Guanche mummies had previously given Dr Hodgkin so very different an impression regarding the stature of this lost race, that his interest and surprise were excited by these relations, and he was in consequence induced to make inquiries by correspondence with his friends in the Canary Islands, and by more accurate investigation of the remains preserved in European collections.

The measurements of eight or nine individuals, males and females, of whom the skeletons are wholly or in part preserved, range from 4 feet 6½ inches to 4 feet 6¾ inches for the whole height, which exhibits a diminutive stature even for the tallest. Dr Hodgkin does not presume to infer from the facts which he has adduced that the statements of the authors alluded to are erroneous, but he conjectures that the Canary Islands, like many other parts of the globe, may at different periods have been inhabited by people of different races, even before the arrival of the Spaniards. The people found by the first Europeans appear to have been of the same family with the Birbirs of Africa, as indicated by language, physical character, &c. They possessed, however, some characters which distinguished them from the Birbirs, such as the making of mummies and some other customs. The author of the paper suggested the careful investigation of all accessible relics of the ancient inhabitants, the comparison of the Guanche and Birbir languages, in order to detect in the former words distinct from the latter, and a minute reference to original writers, as affording the possible clues by which this ethnological difficulty may be overcome.

38. *On the Stature and relative Proportions of Man at different Epochs and in different Countries*, by W. B. Brent. The average height of Englishmen is placed at 5 feet 7½ inches: the army returns, which are likely to give a good idea of the peasantry, range from 5 feet 6 inches to 5 feet 7 inches: the yeomanry, including a higher class, range from 5 feet 1 inch to 6 feet 3 inches. The French conscripts, officially stated, give an average of 5 feet ¾ inches, but Mr Brent, from his own observation, would place the French average considerably higher. The observations made by Prof. Forbes amongst the pupils of his own class in Edinburgh, placed the Irish as the tallest, the Scotch next, and then the English. The Belgians appear to be of still lower stature.

List of Patents granted for Scotland, from 20th March to 11th June 1845.

1. To Octavius Henry Smith, of Wimbledon, in the county of Surrey, Esq., "certain improvements in steam engines, boilers, and condensers."—20th March 1845.

2. To Robert Heath the younger, of Kidsgrove, in the parish of Wolstanton, in the county of Stafford, coal-agent, "improvements in heating ovens and kilns used in the manufacture of china, bricks, tiles, and other articles of earthenware."—24th March 1845.

3. To John Berkeley Cotter, of the city of Dublin, gentleman, "improvements in the preparation and manufacture of woven fabrics or tissues applicable to various useful purposes."—25th March 1845.

4. To John Baptiste Simeon Teissier, of Paris, engineer, and Antoine Hyppolyte Triat, of Paris, professor of gymnastics, "improvements in propelling vessels, carriages, and agricultural machines."—26th March 1845.

5. To William Willcocks Sleigh, late of St James' Square, in the county of Middlesex, but now of Stamford Brookhouse, Chiswick, in the same county, doctor of medicine and surgeon, "a hydro-mechanic apparatus for producing motive power."—2d April 1845.

6. To Thomas Dunn, of Manchester, in the county of Lancaster, engineer, "certain improvements in, or applicable to, turn-tables, to be used on or in connection with railways."—4th April 1845.

7. To John Sykes, of Hollinwood, in the county of Lancaster, machine-maker, and Adam Ogden, of Hey Chapel, in the parish of Ashton-under-Lyne in the said county, gentleman, "certain improvements in machinery for preparing and cleaning wool, cotton, and similar fibrous material."—4th April 1845.

8. To William Cormack, of the Commercial Road, in the county of Middlesex, chemist, "improvements in purifying gas."—4th April 1845.

9. To Robert Kerr, of Thread Street, in the town of Paisley, and county of Renfrew, in that part of Great Britain called Scotland, manufacturer, "certain improvements in hand-loom weaving, and for producing a double fabric of raised figured work in the same loom, by process of weaving."—7th April 1845.

10. To John Spencer, of the Phœnix Iron Works, West Bromwich, in the county of Stafford, agent, "improvements in manufacturing or preparing plates of iron, or other metal for roofing, and other purposes to which the same may be applicable."—7th April 1845.

11. To James Napier, of Hoxton, in the county of Middlesex, dyer, "improvements in treating mineral-waters, to obtain products therefrom, and for separating metals from other matters."—8th April 1845.

12. To George Hurwood, of Ipswich, engineer, "improvements in apparatus for moving and fastening windows."—14th April 1845.

13. To Charles Robert Roper, of Hackney, in the county of Middlesex, chemist, "improvements in the manufacture of gelatine."—16th April 1845.

14. To John Taylor, of the Adelphi, in the county of Middlesex, gentleman, being a communication from abroad, "improvements in

separating metals from each other, and from certain combinations with other substances."—16th April 1845.

15. To John Chanter, of the city of London, patentee and proprietor of patents, and civil engineer, "improvements in furnaces, fire-bars, hot-air generators, and flues."—17th April 1845.

16. To Stephen Perry, of Woodland Place, St John's Wood, in the county of Middlesex, gentleman, "improvements in springs to be applied to saddles, to girths, to belts and bandages, improvements in the application of springs to locks and other fastenings, to paper-holders, to window-blind racks, to window-sashes and doors, to seats and elastic surfaces, for sitting and reclining upon, and improvements in elastic bands." —21st April 1845.

17. To Samuel Hall, of King's Arms Yard, in the city of London, civil engineer, "improvements in steam-engines, boilers, furnaces, and flues, in consuming fuel, in preventing smoke, and in propelling vessels." —21st April 1845.

18. To William Newton, of the office for Patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, being a communication from abroad, "certain improvements in treating and preparing oil or fatty matters."—22d April 1845.

19. To Samuel Porritt, of Edenfield, in the county of Lancaster, manufacturer, "certain improvements in machinery or apparatus for preparing and carding wool."—22d April 1845.

20. To Charles Louis Felix Franchot, of Paris, in the kingdom of France, engineer, "improvements in air-engines."—28th April 1845.

21. To John Herbert Blakey, of Dundee, in the county of Forfar, flax-spinner, "improvements in spinning-throstles."—30th April 1845.

22. To Elijah Galloway, of the Strand, in the county of Middlesex, engineer, "improvements in propelling railway-carriages."—30th April 1845.

23. To James Caldwell, of Broad Street, Ratcliff, in the county of Middlesex, Esquire, "improvements in capstans, windlasses, and machinery for raising and lowering weights, and also in ships' riding-bits." —30th April 1845.

24. To Thomas Bazley junior, of Manchester, in the county of Lancaster, cotton-spinner, "certain improvements in tube-flyers used in machinery for roving and slubbing cotton and other fibrous substances." —2d May 1845.

25. To Henry Phillips, of Clist Honiton, in the county of Devon, chemist, "improvements in purifying gas."—5th May 1845.

26. To John Coope Haddan, of Liverpool Street, King's Cross, in the county of Middlesex, civil engineer, "improvements in preparing sleepers, chairs, and spikes, and constructing wheels for railways."—5th May 1845.

27. To John Sylvester, of Great Russell Street, Bloomsbury, in the county of Middlesex, civil engineer, "improvements in stoves and fire-places."—7th May 1845.

28. To Henry Borriskill Taylor, of Piccadilly, lamp manufacturer, "improvements in apparatus for transmitting light from lamp and other burners."—7th May 1845.

29. To Thomas Brown Jordan, of Cottage Road, Pimlico, in the county of Middlesex, mathematical divider, "improvements in machinery for cutting, carving, and engraving."—22d May 1845.

30. To **Frederick Ransome**, of Ipswich, engineer, "improvements in the manufacture of artificial stone, and in combining small coal and other matters, and in preserving wood."—22d May 1845.

31. To **George Spencer**, of Hungerford, West Strand, in the county of Middlesex, engineers' draftsman, "improvements in propelling vessels on inland waters."—22d May 1845.

32. To **Henry Jones**, of Nos. 36 and 37 Broadmead, in the parish of St James, in the city of Bristol, baker, "a new preparation of flour for certain purposes."—27th May 1845.

33. To **Charles Joseph Hulmandel**, of Great Marlborough Street, in the county of Middlesex, lithographer, "certain improvements in producing patterns upon earthenware and porcelain."—30th May 1845.

34. To **James Heath Lewis**, of Dover, in the county of Kent, printer, "certain improvements in printing."—2d June 1845.

35. To **John Kingsby Huntley**, of John Street, Minories, in the city of London, merchant, being a communication from abroad, "improvements in the manufacture of manure."—4th June 1845.

36. To **Arthur Parsey**, of Spur Street, Leicester Square, in the county of Middlesex, artist and scientific draughtsman, "improvements in obtaining motive power."—6th June 1845.

37. To **Thomas Lawes**, of Old Kent Road, in the county of Surrey, gentleman, "improvements in propelling carriages on rail and other roads, and boats or vessels on canals or rivers, which improvements are also applicable to machinery in general."—9th June 1845.

38. To **William Shepherd**, of Manchester, in the county of Lancaster, calico printer, "certain improvements in the art of printing calicoes and other surfaces."—11th June 1845.

39. To **Benjamin Seebohm**, of Horton Grange, in the parish of Bradford, in the county of York, mechanist, "an improved mode of manufacturing certain descriptions of chains."—11th June 1845.

New Publications received to be noticed in our next Number.

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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

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*Chemical Examination of the Elie Pyrope or Garnet.** By ARTHUR CONNELL, Esq., Professor of Chemistry, University of St Andrews, F.R.S.E., &c. Communicated by the Author.

THIS mineral is found on the sea-shore at Elie, in the county of Fife, proceeding from the debris of trap-rocks. It has been long known to Scottish mineralogists, and has been regarded as one of the varieties of precious garnet, occasionally getting the name of pyrope. It is not crystallized, but occurs in angular grains, which evidently have not come from any distance. Its other leading external characters, including transparency and colour, agree with those of precious garnet and pyrope; the colour approaching the deeper tint of pyrope. Its specific gravity I found to be 3·661 at 60°. I am not aware that this substance has been previously examined chemically; and in subjecting it to analysis, my principal object was to endeavour to ascertain whether it partook more of the chemical nature of pyrope, or of the ordinary varieties of precious garnet.

The formula for garnet is now pretty well ascertained, and that applied to precious garnet, $f\,S + A\,S$, imports about 40 per cent. of protoxide of iron; and, accordingly, the ordinary varieties of precious garnet, in the hands of different analysts, have yielded large quantities of oxide of iron, varying from 25 to 40 per cent. On the other hand, the chemical constitution of pyrope can hardly be brought within the garnet formula ; and although in external characters it approaches more nearly to the precious varieties, yet it deviates more from them than from some of the other kinds of garnet in chemical nature, containing a much smaller proportion of oxide of iron, the amount varying from 10 to 15 per cent. Pyrope is also well known to contain from 2 to 6 per cent. of one or other of the oxides of chrome, although it may admit of doubt, as will be afterwards seen, whether this is an essential constituent. There were thus evidently data for attempting to determine, by chemical evidence, whether the Elie mineral belongs more to the ordinary precious garnet or to pyrope.

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* Known to amateur collectors under the name *Elie ruby*.

A search was also made for yttria, as it was announced a few years ago by Dr Apjohn that he had detected that constituent in pyrope ; but as no farther communication has been made by him on the subject, although promised, it is probable that this result has not been confirmed ; and, indeed, was improbable in itself, as no such constituent has been noticed by the other eminent analysts who have examined pyrope.

Before the blowpipe, with salt of phosphorus, the Elie mineral gave only the most ambiguous traces of a chrome reaction ; whereas, in the same circumstances, Bohemian pyrope yielded a decided greenish tint.

Twenty grains of the Elie mineral, in finest powder, were fused by a charcoal fire, with four times their weight of carbonate of potash. The mass was treated with muriatic acid, and no smell of chlorine observed. The usual steps were taken to separate silica. The precipitate subsequently obtained by ammonia was dissolved in muriatic acid, and the solution boiled with excess of caustic potash, which took up the alumina ; and the matter left by the potash redissolved in muriatic acid. Into this muriatic solution, after adding tartaric acid and excess of ammonia, a current of sulphuretted hydrogen was conducted, which threw down sulphuret of iron with a little sulphuret of manganese. The filtered liquid was then evaporated to dryness, and the residue incinerated. It was pure white, and was carefully examined to ascertain whether it contained yttria. It was dissolved in muriatic acid, and muriate of ammonia, and excess of ammonia added. Some white gelatinous matter fell, which, by ignition, got a greenish-yellow tint, magnesia being left in solution. The ignited precipitate was again dissolved in muriatic acid, and treated with muriate of ammonia and excess of ammonia, which caused once more a gelatinous precipitate. This was dissolved to a great extent by boiling with caustic potash, leaving some matter, which was principally oxide of iron, but gave a permanent fine, although pale, emerald-green to salt of phosphorus, and, therefore, contained a trace of oxide of chrome. The caustic potash, treated with muriatic acid and carbonate of ammonia, yielded a white gelatinous precipitate, which gave the fine blue of alumina, with nitrate of cobalt. In short, the white residue of incineration, consisted of magnesia, alumina, a very little oxide of iron, and a trace of oxide of chrome.

The other necessary and usual steps were then taken to separate the different constituents of the mineral, the lime being thrown down by oxalate of ammonia, and the magnesia by boiling with carbonate of potash.

A farther search was made for chrome, by fusing a portion of the mineral with carbonate of soda and a little nitre ; but none was found in this way when the fused mass was treated with water, and duly examined.

The only attempt made to ascertain the state of oxidation of the iron, was by digesting a portion of the finely powdered mineral with muriatic acid in a close vessel, and then testing it, after neutralization with ammonia, by the two prussiates of potash. The reaction was decidedly that of peroxide, and not at all of protoxide.

In the twenty grains of the mineral there were found—

		In 100.	Oxygen.	
Silica,	8·560	42·80	22·23	4
Alumina,	5·730	28·65	13·38	3
Peroxide of iron,	1·863	9·31	2·85	
Protoxide of Manganese,	0·050	0·25	·05	1
Lime,	0·956	4·78	1·35	
Magnesia,	2·135	10·67	4·10	
Oxide of chrome, trace,				
	19·294	96·46		

As there was thus some loss on the analysis, a search was made by ordinary processes for any constituent which might have been as yet unnoticed, such as moisture, phosphoric and fluoric acids and alkalies, but no such constituents were found. I have reason to believe that the loss fell chiefly on the magnesia, no steps having been taken to separate any farther traces of that constituent which might have escaped precipitation by the carbonate of potash.

Even if the oxide of iron in this mineral were held to be protoxide, there would be quite as much difficulty in bringing the result under the garnet formula as there is in bringing the leading analyses of Bohemian pyrope under it. This circumstance, as well as the general conformity between the result here given, and the analyses of pyrope referred to, comprising those of Klaproth, Wachtmeister, and Von Kobell, particularly as respects the considerable quantity of magnesia, and the comparatively small quantity of oxide of iron, although with some apparent discrepancy as to the state of oxidation of the latter substance, tend to shew a close connection between the Elie mineral and pyrope. The occurence, also, in the former, of a very minute but decided trace of oxide of chrome, appears still farther to establish this relation, and perhaps shews that that substance can hardly be viewed in pyrope as an essential constituent.

The specific gravity leads to a similar view as to this connection ; for, whilst that of precious garnet is upwards of 4, that of pyrope is only 3·78, and that of the Elie mineral 3·661, as already stated.

If we should hold the iron to be in the state of peroxide, as the reactions, so far as tried, indicated, we might represent the constitution of the Elie mineral by the formula $\left.\begin{array}{c}\mathrm{M}g\\ \mathrm{C}\\ \mathrm{M}n\end{array}\right\} S + 3 \left.\begin{array}{c}\mathrm{A}\\ \hline \mathrm{F}\end{array}\right\} S$; and, on a similar view, this formula would not be much at variance with the leading analyses of Bohemian pyrope ; but, as the iron in pyrope is usually reckoned protoxide, such a view would, I fear, hardly be admitted. The colour of the glass obtained on fusing garnets, seems, however, a doubtful source of evidence on that point. Thus, melanite gives a black glass with the blowpipe, although the iron in it is held to be peroxide; and pyrope, although it yields in that way, a black glass also, afforded to Klaproth a grey or brown glass in a crucible.

Researches in Elucidation of the Distribution of Heat over the Globe, and especially of the Climatic Features peculiar to the Region of the United States. By SAMUEL FORRY, M.D., Author of "The Climate of the United States, and its Endemic Influences," Editor of "The New York Journal of Medicine and the Collateral Sciences," &c.

(Concluded from page 105.)

Another important subject is the influence of temperature on the geography of plants, which has been ably treated by M. De Candolle. In considering its relation with the organic life of plants, it is necessary to keep in view three objects:—1. The mean temperature of the year. 2. The extreme mean temperature both in regard to heat and cold. 3. The distribution of temperature among the different months of the year. The last is the most important; but in the investigation of vegetable geography it is requisite to estimate the simultaneous influence of all physical causes,—soil, heat, light, and the state of the atmosphere, as regards its humidity, serenity, and variable pressure. Each plant has generally a particular climate in which it thrives best; and beyond certain limits it ceases to exist. Hence, having seen the great variations of summer and winter temperature on the same isothermal line, the absurdity of limiting a vegetable production to a certain latitude or mean annual temperature, is apparent. To say that the vine, the olive, and the coffee tree require, in order to be productive, annual temperatures of 53° 60′, 60° 80′, and 64° 40′, is true only of the same system of climate. As the annual quantity of heat which any point of the globe receives varies little during a long series of years, the variable product of our harvests depends less on changes in the mean annual temperature than in its distribution throughout the year. Thus, climates, in regard to vegetable productions, are strongly characterised by the variations which the temperature of months and seasons experience. But this subject is too extensive for present investigation. It has been already observed that the parallels which, in Western Europe, yield the olive and the orange, are with us productive of ice and snow; but on the Pacific coast of our territory the requisite temperature is found at Fort Vancouver, which is in the latitude of Montreal. Here vegetation grows luxuriantly in mid-winter. That vegetables common to the warm climates, as the orange, lemon, citron, fig, olive, and pomegranate, can be successfully cultivated here, is no longer a doubtful question; and the cotton plant also is said to flourish well. The British Fur Company, at Fort Vancouver, besides cultivating all those plants, have likewise a fine grapery, which yields fruit equal to those in France.

The influence of the unequal distribution of heat upon vegetable geography is beautifully illustrated in the four systems of climate demonstrated on the same parallels in the Northern Division of the United States; and if we extend the comparison to the Pacific coast, a fifth system may be enumerated on the same latitude. Taking the coast of New England, the region of the great lakes, and the Pacific coast, the difference between the mean temperature of winter and spring varies from 6° 67′, to 18° 42′; while, in the excessive climate of the region west of the lakes, and that intermediate to the lakes and the Atlantic, this difference ranges from 18° 82′ to 30° 83′; and accordingly we find, as already explained, that spring and summer, in the latter, are confounded with each other, and that the sudden excess of heat renders the progress of vegetation almost perceptible. It is necessary, however, to add, that the low ratio of 6° 67′ occurs on the Pacific coast, the lowest average in the Northern Division of the United States being 11° 67′. In the Middle and Southern Divisions, this vernal increase of temperature gradually diminishes, until finally, at Key West, it is only 5° 99′. But there is another important feature to be observed. Not only is the vernal increase greater in excessive climes; but as it supervenes upon a lower winter temperature, the effect produced on the development of vegetation is in an inverse ratio. The vernal increase of 30° 83′, for example, at Fort-Snelling, comes upon a mean winter temperature of 15° 95′, while at Fort-Sullivan, on the same parallel, the increase of only 17° 16′ follows a winter temperature as high as 22° 95′. Between northern and southern latitudes, this contrast is still more marked; for while, at Fort-Snelling, there is a difference of 13° 46′ between the months of February and March, and at Key West only 1° 56′, the temperature of February at the former is 18° 66′, and at the latter 72° 15′.

What month expresses the nearest equivalent to the mean annual temperature?—This is a question which has excited considerable controversy, and in regard to which there still exists a difference of opinion. By Kirwan it is strenuously contended that the month of *April* expresses this equivalent; while Humboldt, on the other hand, shews, by extensive tabular statements, that *October* is better entitled to this characteristic; and on either side of this question are arranged many other authors of lesser note. As the laws of Nature are universal, these phenomena, like all others, must be susceptible of systematic arrangement; and lest it may be thought presumptuous in the author to attempt to decide between such high authorities, he will state in advance that the diverse systems of climate presented in the northern regions of the United States, on the same parallels, afford a means of comparison doubtless heretofore unequalled.

As respects the controverted question, whether April or October expresses a nearer equivalent to the mean annual temperature, the following deductions is clearly authorised by the tabular abstracts appended to the writer's work on "The Climate of the United States," &c. *In excessive climates, the mean temperature of April is generally as high as that of the year, while that of October is considerably higher; and in modified climes, it will be found that the former is generally as much lower as the latter is higher.* Now, this relation is precisely what might have been anticipated from a consideration of the preceding facts; for as the vernal increase of temperature is always much greater in excessive than in modified climates, it follows that if, under any circumstances, April expresses a nearer equivalent than October, it must be when its mean temperature is augmented by a sudden vernal increase. These results, comprising some of the posts in the Northern Division of the United States, are exhibited in the following table :—

Excessive climates remote from large bodies of water.	No. of years of observations.	Mean Temperature of		
		The year.	April.	October.
		°	°	°
Hancock Barracks,	2	41·21	43·85	45·84
Fort-Snelling,	8	45·83	46·00	49·27
Fort-Howard,	9	44·92	43·28	47·51
Council Bluffs,	5	51·02	51·82	53·65
Fort-Armstrong,	4	51·64	51·26	54·58
Modified climates on the ocean and lakes.				
Salem, Massachusetts,	33	48·61	46·11	51·15
Fort-Vancouver,	1	51·75	46·00	54·00
Fort-Brady,	6	41·39	38·50	45·52
Fort-Sullivan,	5	42·95	43·28	47·51
Fort-Preble,	5	46·67	45·44	49·28
Fort-Niagara,	2	51·69	47·52	58·94
Fort-Constitution,	4	47·21	45·31	50·43
Fort-Wolcott,	9	50·61	46·41	54·45
Fort-Trumbull,	2	55·00	51·00	58·10
Fort-Columbus,	9	53·00	49·89	55·82

It is thus seen that in excessive climates the law above stated holds good invariably. There is but one exception in the tables appended to the author's work before alluded to, viz., Fort-Crawford ; but the results of this post are based on only two years' observations. Fort-Howard, it is seen, has, in April, a somewhat lower mean than that of the year, which, as it differs from the rest in this respect, in consequence of having its temperature *partially* modified by the waters of Green Bay, is an exception which confirms the rule. At the posts in the modified climates, the mean temperature of April, with the single exception of Fort-Sullivan, is generally as much lower as that of October is higher than the annual mean. This law is beautifully illustrated in the results obtained at Salem, based on thirty-three years' observations ; the mean of April being 2° 50′ lower, and that of October being 2° 54′ higher than the annual mean. Fort-Vancouver, which is not situated near a large body of water, derives its uniform climate from its position near the western coast of the continent.

A decision of this long-mooted question is thus presented, illustrating the ancient axiom, that truth is never found in extremes. Kirwan, however, was somewhat nearer the truth than Humboldt. As regards any credit that may pertain to this explanation—a deduction that the writer made several years ago—he considers it exclusively his own.

Reference may be made to the "*well-established fact of meridians of greatest cold*," so called by Traill in the Encyclopædia Britannica. "The remarkable fact," he says, "of the influence of *longitude* on temperature, leads to the conclusion, that on each side of the equator there are two meridians, under which the mean temperature is lowest. These have been termed, by Sir David Brewster, the *cold meridians*, and their extremities are the *poles of greatest cold.* The portions of these in the northern hemisphere may be approximated from recent investigations; and perhaps we shall not greatly err if we assign the longitude of 95° west for the American, and of 100° east for the Asiatic cold meridians. The apparent coincidence of the cold meridians with the general directions of Hansteen's lines of no variation, is perhaps more than accidental, when we reflect that there seem to have been, in former ages, migrations of the cold meridians eastward and westward, coincident, as far as we can judge from recorded changes of climate in northern countries, with similar migrations of the magnetic needle."

This theory of cold meridians is at best extremely problematical. If there is any truth in the laws of climate, as based on physical geography, then is this theory no more than the "baseless fabric of a vision.'' It is true that the meridians selected are the coldest in some latitudes of the northern hemisphere, inasmuch as they traverse the interior of the continents, considerably near the eastern or colder side. The longitude of 95° W., for instance, passes nearly two degrees west of Fort-Snelling, Iowa, which is very probably the coldest meridian in the United States; but as this same meridian passes through the Gulf of Mexico, the result there at once explodes the whole hypothesis. And as the same meridian continued into the southern hemisphere, traverses the Pacific Ocean, the theory is again at fault; for the laws of climate resulting from physical geography, place it about 30° farther east on the continent of South America; and in the Old World, the coldest meridian, if continued into the southern hemisphere, instead of being that of 100°, will be found either in Africa or New Holland. But the circumstance of the migration of these meridians, makes still greater demands upon our credulity, inasmuch as it was directly counter to the well-established principle, that any alteration in the climate of a locality supposes a corresponding alteration in its physical features. That there are *poles of greatest cold* corresponding to the terrestrial magnetic poles, as distinguished from the poles of rotation, is, however, quite probable.

Does the climate of a locality, in a series of years, undergo any permanent changes? The question has been much debated, whether the temperature of the crust of the earth or of the incumbent atmosphere, has undergone any perceptible changes since the earliest records, either from the efforts of men in clearing away forests, draining marshes, and cultivating the ground, or from other causes. So general is the opinion that the temperature of the winter season in northern latitudes, has become higher in modern than it was in ancient times, that it has been regarded as an admitted fact. Among the writers of reputation who have adopted and maintained this opinion, are the Abbé Du Bos, Buffon, Hume, Gibbon, Volney; and in our own country, Jefferson, Williams, and Dr Holyoke. By them it is alleged that the winters of the south of Europe, in the time of the Roman emperors, were, according to the concurring testimony of many authors, much more severe than now. In proof of this assertion, they quote many passages from the ancient authors, Juvenal, Virgil, Ovid, &c.; and in regard to Gaul and Germany, the writings of Cæsar, Diodorus Siculus, &c.

Gibbon in his "Decline and Fall of the Roman Empire," has contributed perhaps more than any other to perpetuate the affirmative of this opinion. The ignorance of the great laws of climate betrayed by him in the observation, that "Canada, *at this day, is an exact picture of ancient Germany*," finds an excuse in the fact that he lived before the epoch of Baron Humboldt; but it is truly surprising that Malte Brun should, many years after, make the same comparison. Gibbon's reputation is that of a *historian*; but it is easy to shew, as we have done elsewhere, that he falls short even in this character, as regards the assertion, when speaking of transporting heavy waggons over the frozen rivers of ancient Germany, that "*modern ages have not presented an instance of a like phenomenon.*"

As the full discussion of this question alone would take up the space allotted to this article, the most general view of it must here suffice. For several years past, we have devoted much attention to climatology, ransacking all the libraries to which we have had access for works treating on this subject; and we early became satisfied that the universal opinion, that modern winters have experienced a material increase of temperature, has no foundation in reality. As we have no exact instrumental observations of temperature that go back much farther than a century, our information in regard to more remote periods being derived from loose notices, scattered through the old chronicles, relative to the state of the harvest, the quantity of the vintage, or the endurance of the frost and snow in the winter, great allowance must be made for the spirit of exaggeration which tinges all rude historical monuments. It must be borne in mind that the thermometer is a comparatively modern instrument, invented in 1590, but still left so imperfect, that it was not till the year 1724 that Fahrenheit succeeded in improving it sufficiently to warrant a comparison of observations. It is not surprising that one should hear continual complaints of the altered condition of the seasons, especially from elderly persons, in whom the bodily frame has become more susceptible to the impressions of cold; but similar lamentations, like the prevalent notion that men in general were taller in the earlier ages of the world, have been repeated by the poets and the vulgar from time immemorial.

The facts stated by the Roman poets, if not exaggerated, doubtless, in many instances, stand isolated, not unlike the circumstance recorded in relation to the Baltic, which, in

1688, was so firmly frozen, that Charles XI. of Sweden crossed it with his army; or the similar fact that in the winter of 1779–80, horse and artillery were transported over the ice in the harbour of New York. We have elsewhere clearly established, from historical evidence, but which is here precluded from want of space, that the most remarkable extremes of heat and cold have been frequently recurring ever since the time of the Romans referred to above, notwithstanding the opinion of Gibbon to the contrary.

Although in possession of the facts requisite to establish the opinion that the climate of Europe has undergone no material change since the era of Julius Cæsar, yet it was not without considerable hesitancy that we announced this conclusion. What, then, was our surprise, in finding subsequently a remarkable coincident confirmation of this deduction in the last work of that extraordinary man, Noah Webster, LL.D., entitled "A Collection of Papers on Political, Literary, and Moral Subjects," published in 1843. One of the papers is "*On the supposed Change in the Temperature of Winter*," which, containing forty-four octavo pages, consists of two distinct essays read before the Connecticut Academy of Arts and Sciences,—the first in 1799, and the supplementary remarks in 1806.*

In this investigation, Dr Webster commences with the dawn of history. From several passages in the Scriptures, of equivocal import, written as early as the days of Moses and David, it has been hastily concluded, that the climate of Palestine or Judea has undergone a most remarkable melioration. But the fallacy of this inference he establishes most conclusively, proving that the climate of Palestine has experienced no increase of temperature for more than 3000 years. In every part of the Bible mention is made of olives, figs, and pomegranates; and even in the time of Moses, the spies sent to explore the country came back laden with figs and pomegranates. According to Pliny, "Judea is particularly renowned for palm-trees or dates;" and that these trees were not first introduced into Judea by the Israelites when they migrated from Egypt, is evident from the single fact, that they found in the plains of Moab, and in the vicinity of Jericho, the most luxuriant palm-trees. Even the word Jericho, which is called in Deuteronomy "the city of palm-trees," signifies in the Ethiopic, according to Dr Webster, a palm-tree. "We have then," says Dr W., from these and other facts adduced, "*certain proof* that Palestine, more than 3000 years ago, was a milder climate than Italy, milder than the south of France, as mild as the coast of Africa at that time, and milder than South Carolina at this day."

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* These Essays were published in New Harem, A.D., 1810, constituting the first article in the "Memoirs of the Connecticut Academy of Arts and Sciences," vol. i., part 1, p. 216, 8vo.—Eds.

It is by the same summary mode of argument, that Dr W. dismisses the seeming facts adduced by the Abbé Du Bos, Gibbon, Hume, Williams, and others, from the writings of Homer, Virgil, Pliny, Juvenal Livy, Ælian, Horace, and Julius Cæsar. In regard to what writers have recorded of the winters of ancient Gaul and Germany, our own views, given in detail elsewhere, find a singular confirmation in those of Dr Webster. The remark of Gibbon, already quoted, referring to the freezing of the Rhine and Danube, that "modern ages have not presented an instance of a like phenomenon," he says, "is contrary to all historical evidence, and even to facts which took place during that author's life."

Dr W. dwells particularly upon the vegetables which flourished in the Augustan age in Gaul; and these evidences he regards as our own safest guides. He concludes with the following striking remark: "Olives grow and mature there (the south of France), precisely within the limits marked by Strabo and Pliny; and, as far as we can judge, not a league farther north than they did 1800 years ago." But as respects the influence of temperature on the geography of plants, Dr W.'s remarks are defective, in consequence of his limiting his comparisons to the *mean annual temperature* of a locality, which is entirely subordinate to the distribution of the temperature *among the different months of the year*. It is true De Candolle had not written in 1799; but in publishing in 1843, it should not have been forgotten that a new era had arisen in meteorology.

Dr Webster's final conclusion from this extensive and most learned array of historical facts, is for the first essay, that, as respects both the old and new world, "the hypothesis of a moderation of climate appears to be unsupported." And, for the second—"But we can hardly infer, from the facts that have been yet collected, that there is, in modern times, an actual diminution of the aggregate amount of cold in winter, on either continent."

Now, as Dr W.'s views relative to the influence that clearing the country of its forests exercises upon the seasons of the year, also correspond remarkably with our own deductions, we cannot fail to discover a marked coincidence in the similarity of his conclusions and that previously expressed by ourselves: "All observations, then, thus far confirm the belief in the general stability of climates. As regards the seasons, it will be shewn, however, that in countries covered with dense forests, the winters are longer and more uniform than in dry, cultivated regions; and that in summer, the mean temperature of the latter is higher. Hence, in regard to the opinion generally entertained, that the climate of Europe has been very much meliorated since the days of Julius Cæsar, it is clearly apparent, from the foregoing facts, that it is far from being sustained by evidence sufficient to enforce conviction. But, at the same time, while it is obvious that no material change has taken place, for the last 2000 years, in the climate of Europe, the conjecture that it has gradually acquired rather a milder character, or, at least, that its excessive severity seems, on the whole, to occur less frequently, appears to be warranted."

It is thus seen, and it is farther shewn, that whatever difference there may be between the seasons of ancient and modern times, they find an explanation without resorting to the unphilosophical hypothesis of a general augmentation of temperature. So universal has been the opinion, that modern writers have experienced a material increase of temperature, that Dr Webster remarks,—"Indeed I know not whether any person, in this age, has even questioned the fact." Under these circumstances, the coincidence that both of us, independent of each other, arrived at the same conlusion—a conclusion adverse to the *vox populi*, which thus seems to be not always the *vox Dei*, may be regarded as affording a confirmation of the legitimacy of the deduction.

We have thus attempted to answer the question, *does the climate of a locality*, in a series of years, undergo any permanent changes? And we may add, that although the mean temperatures, as has been ascertained by instrumental observations, vary from one another irregularly, either a few degrees above or below the *absolute* mean temperature of the place; yet it has not been found that the temperature of a locality undergoes changes in any ratio of progression. At the same time, this series of atmospheric changes, however complicated and perplexing, there is good reason to believe, is as determinate in its nature, as the revolutions of the celestial bodies. When, however, the science of meteorology shall have become more advanced, we shall doubtless discover that these apparent perturbations of annual temperatures are real oscillations—vast cycles, which will enable us to predict, no doubt with some degree of certainty, the condition of future seasons.

It now remains to advert to two collateral questions: *Is the climate west of the Alleghanies milder by 3° of latitude than that east? Does the climate of our north-western frontier resemble that of the Eastern States on their first settlement?*

The opinion was early entertained, that the climate of the region west of the Alleghanies, is much milder than that of the district east. Mr Jefferson estimated the difference equivalent to 3° of latitude, as similar vegetable productions are found so many degrees farther north.

These phenomena, M. Volney ascribed to the influence of the southwest winds, which carry the warm air of the Gulf of Mexico up the Valley of the Mississippi. As North America has two mountain chains, extending from northwest to southeast, nearly parallel to the coasts, and forming almost equal angles with the meridian, Humboldt endeavoured to explain the migration of vegetables toward the north, by the form and direction of this great valley, which opens from the north to the south, while the Atlantic coast presents valleys of a transverse direction, which oppose great obstacles to the passage of plants from one valley to another.

The tropical current or trade wind, it is said, deflected by the Mexican elevations, enters the great basin of the Mississippi, and sweeps over an extensive country lying east of the Rocky Mountains; and that when this current continues for some days, such extraordinary heat prevails, even through the basin of the St Lawrence, that the thermometer at Montreal sometimes rises to 98° Fahr. In winter, on the contrary, when the locality of this great current is changed to more southern latitudes, succeeded by the cold winds which sweep across the continent from the Rocky Mountains, or descend from high latitudes, this region becomes subject to all the rigours of a Siberian winter.

Upon the fallacy of these views, it is deemed unnecessary to dilate. It is proved by thermometrical data, that the climate west of the Alleghany is more excessive than that on the Atlantic side, a condition that would seem unfriendly to the migration of plants. Thus, Jefferson Barracks, on the Mississippi, exhibits a greater contrast in the seasons than Washington City; and the same is true in regard to Fort-Gibson and Fort-Monroe, notwithstanding the former is 1° 32′ farther south. That the climate of the Peninsula of Michigan, encompassed by ocean lakes, should prove genial to plants that will not flourish in the same latitudes in the interior of New York, is indeed, consonant with the laws of nature; and that the same plants should flourish 3° farther north in the Valley of the Mississippi than on the eastern side of the mountain, finds a sufficient explanation in the following extract from Murray's Encyclopædia of Geography: "Powerful summer heats are capable of causing trees and shrubs to endure the most trying effects of cold in the ensuing winter, as we find in innumerable instances, and *vice versa*. Hence, in Great Britain, so many vegetables, fruit-trees in particular, for want of a sufficiently powerful sun in summer, are affected by our comparatively moderate frosts in winter; while upon continents, in the same degree of latitude, the same tree arrives at the highest degree of perfection."

As the writer has found the opinions of M. Volney, as well as those of Jefferson, Williams, and Rush, quoted as oracular in every work professing to treat of our climate, it may not be amiss to examine this subject a little more in detail. This French philosopher had the singularly bad fortune of adopting the errors of Dr Rush and Mr Jefferson. For example, according to the former, as we recede from the ocean into the interior of Pennsylvania, "the heat in summer is less intense"—a phenomenon contrary to every law of nature, unless reference was had to the Alleghany elevations; and, in accordance with the latter, the climate becomes colder as we proceed westward on the same parallel until the summit of Alleghany is attained, when this law is reversed until we reach the Mississippi, *where it is even warmer than the same latitude on the sea-board.* This theory, by the way, is based upon the testimony of travellers; and "their testimony," says Jefferson, "is strengthened by the vegetables and animals which subsist and multiply there naturally, and do not in our sea-board."—"As a traveller," adds Volney, "I can confirm and enlarge upon the assertion of Mr Jefferson;" and in regard to the temperature of the regions lying east and west of the Alleghanies, he concurs in the opinion, "that there is a general and uniform difference, equivalent to 3° of latitude, in favour of the basin of the Ohio and the Mississippi." This conclusion, which is not deduced from thermometrical data, rests, it will be observed, upon the phenomena of temperature and of vegetation exhibited in the region of the great lakes. "Even as high up as Niagara," he continues, "it is still so temperate that the cold does not continue with any severity more than two months, though this is the most elevated point of the great platform—a circumstance totally inconsistent with the law of elevations." He proceeds to say, that this climate does not correspond with similar parallels in Vermont and New Hampshire, "but rather with the climate of Philadelphia, 3° farther south. * * * At Albany, no month of the year is exempt from frost, and neither peaches nor cherries will ripen." The influence of the great lakes in modifying temperature has been already so abundantly demonstrated, that farther illustration is deemed supererogatory. The phenomena observed by Volney are truly facts; but the causes being unknown, the theory, in regard to the difference of temperature east and west of the Alleghanies, was naturally suggested. Instead of deducing general laws from universal facts, this theory of Volney and Jefferson was, as will be seen, a premature deduction—the result of hasty and partial generalization.

M. Volney also presents an extended investigation of the system of winds in the United States; and the ignorance of this celebrated traveller in thus attempting to explain the meteorological phenomena peculiar to the region of the great lakes, shews how little was known, forty-five years ago, of the laws of meteorology. In reference to the Trans-Alleghany region, he thus remarks:—"I think I have clearly demonstrated, that the south-west wind of the United States is nothing but the trade wind of the tropics, turned out of its direction and modified; and that, consequently, the air of the western country is the same as that of the Gulf of Mexico, and previously of the West Indies, conveyed to Kentucky. From this datum flows a natural and simple solution of the problem, which, at first, must have appeared perplexing, *why the temperature of the western country is hotter by* 3° *of latitude than that of the Atlantic coast*, though only separated from it by the Alleghany mountains. The reasons of this are so palpable, that it would be only wearying the reader to give them. Another consequence of this datum is, that the south-west winds being the cause of a higher temperature, it will extend the sphere of this temperature so much the farther, the greater the facility with which it can pervade the country; and this affords a very favourable presage for the parts that lie in its way, and are exposed to its influence, namely, those in the vicinity of Lakes Erie and Ontario, and even all the basin of the river St Lawrence, into which the south-west wind penetrates."

Now, these are the opinions still maintained at the present day, to account for the supposed fact of the higher temperature of our tramontane region. It is a good rule in philosophy to ascertain the truth of a fact before attempting its explanation—a truism, the observance of which would have saved M. Volney the labour of constructing his complex theory of the winds. All thermometrical results confirm the law, that, in proportion as we recede from the ocean or inland seas, the climate grows more excessive; and that the meteorological phenomena of the region of the great lakes do not arise from the agency of tropical winds, is apparent, from the single fact, that the winters are several degrees warmer, and the summers at least ten degrees cooler, as regards the mean temperature of the seasons, than positions one hundred miles distant, notwithstanding on the same parallel, or even directly south; and, consequently, equally exposed to the current from the Gulf of Mexico. Volney's theory, in truth, bears a contradiction upon its face; for while he ascribes the modified climate of the lakes to the agency of tropical winds, he admits that the intermediate country traversed by these winds has a much more rigorous climate.

The influence of predominant winds is manifest, however, throughout the United States; for one prevailing wind, the south-west, blows from a warm sea; another, the north-east, from a frigid ocean; and a third, the north-west, from frozen deserts.

The modification in the climate of the valley of the Mississippi, whatever may be its degree, arises from the combined agency of the Gulf of Mexico and the Great lakes; for if land were substituted for the area of the latter (93,000 square miles), that region would become, so far as the social state of man is concerned, scarcely habitable.

The opinion that the climate west of the Alleghany range is milder by 3° of latitude than the east,—an opinion, quoted generally by writers as an established fact, arose from the circumstance that the United States present, on the same parallel, different systems of climate,—causes upon which the geographical distribution of plants mainly depends.

In reference to the organic life of plants, it is well known that to some entirely different constitutions of the atmosphere are adapted. In respect to the culture of vegetables, it is necessary to keep in view three objects,—the mean temperature of the summer, that of the warmest month, and that of the coldest month; for some plants, indifferent to high summer temperature, cannot endure the rigours of winter; others, slightly sensible to low temperature, require very warm, but not long summers; while, to others, a continuous rather than a very warm summer seems best adapted. The development of vegetation in the same mean temperature is also retarded or accelerated, according as it is struck by the direct rays of the sun, or receives the diffuse light of a foggy atmosphere. On these causes depend, in a great degree, those contrasts of vegetable life observed in islands, in the interior of continents, in plains, and on the summits of mountains. As the region of the great lakes does not exhibit a greater contrast in the opposite seasons than that of Philadelphia, it follows that plants which, from not being adapted to extremes of temperature, cannot endure the severe winter of Albany, will flourish in the more equalized climate of the same latitude on the ocean or the great lakes.

Thus, as Volney and Jefferson saw that the vegetation of Philadelphia is found in the modified climate of our northern lakes, while similar plants will not flourish on the same parallels in the interior of New York, Vermont, and New Hampshire, the theory in regard to the difference of temperature, east and west of the Alleghanies, was naturally suggested. If, however, these philosophers had chanced to observe the vegetation, by way of comparison, along the coast of Rhode Island or Connecticut, and on the same parallel in Illinois, or farther westward, instead of comparing the region of the lakes and Albany, the world would, *of course*, have been edified with the opposite theory,—viz., that the climate east of the Alleghanies is milder by 3° of latitude than that west. While at Fort Trumbull, Connecticut, the mean winter temperature is 39° 33′, at Council Bluffs it is as low as 24° 47′. Hence plants sensible to a low temperature, which flourish in the climate of the former, will perish in the latter; for while the mean temperature of the coldest month at Fort Trumbull is only 34° 50′, at Council Bluffs it is 22° 61′. This is also demonstrated by the average annual minimum temperature, that of the former being 9°, and that of the latter 16°; and equally so by the minimum temperature of the winter months, that of December, January, and February being, at Fort Trumbull, respectively 20°, 10°, and 16°, and at Council Bluffs, 4°, 13°, and 11°. On the other hand, it will be found that the vegetables which can endure the rigorous climate of Council Bluffs will flourish more vigorously than in the region of Connecticut; for at the former the vernal increase is 27° 47′, and at the latter only 11° 67′. Moreover, the latter increase is added to a winter temperature of 39° 33′; while the former, added to 24° 47′, more than doubles itself, the influence of which upon the sudden development of vegetation has already been pointed out. Those relations, as developed in the tabular abstracts appended to the author's work on "The Climate of the United States, and its Endemic Influences," might be traced out much farther. At Council Bluffs the extreme of temperature in summer is also much greater than at Fort Trumbull, the mean maximum of the former being 104°, and of the latter 87°; and, consequently, the annual average range stands respectively as 120° to 78°. In addition to these facts, it may be observed, that so far as elevation is concerned, that of the lakes being 600 feet, and that of Albany only 130 feet above the sea, the advantage of the comparison is, at first view, on the side of the latter; but this gradual elevation, it has been shewn, exerts no perceptible influence.

Does the climate of our north-western frontier resemble that of the Eastern States on their first settlement?

This question, it is true, has already been decided in the negative; but as changes of climate in the New World also are alleged by Jefferson, Volney, Rush, and Williams, to have supervened, it may be well to make some inquiry into its truth. It is deemed unnecessary to quote here the loose, vague, and general statements of these writers, who thus assert, that, on comparing the results of recent observations on our frontier, with the best authenticated accounts we have of the climate of the Eastern States, in their early settlement, a close similitude is found. The winters, it is said, have grown less cold, and the summers less warm; consequences which are ascribed to the clearing of the forest, and the cultivation of the soil. That the climate of the great lakes resemble that of the sea coast is very apparent; but that the region intermediate, or the one beyond, ever maintained such a relation, is an assumption contrary to the laws of nature.

Dense forests and all growing vegetables, doubtless, tend considerably to diminish the temperature of summer, by affording evaporation from the surface of their leaves, and preventing the colorific rays from reaching the ground. It is a fact equally well known, that snow lies longer in forests than on plains, because, in the former locality, it is less exposed to the action of the sun; and hence, the winters, in former years, may have been longer and more uniform. As the clearing away of the forest causes the waters to evaporate, and the soil to become dry, some increase in the mean summer temperature, diametrically contrary to the opinion of Jefferson, Lyell, and others, necessarily follows. It is remarked by Umfreville that, at Hudson's Bay, the ground in open places thaws to the depth of four feet, and in the woods to the depth only of two. Moreover, it has been determined by thermometrical experiments, that the temperature of the forest, at the distance of twelve inches below the surface of the earth, is, compared with the adjacent open field, at least 10° lower during the summer months; while no difference is observable during the season of winter.

"The mere effect of cultivation," as stated by a writer on Physical Geography, "can never be very considerable in changing a climate;" but although cultivation of the soil may not be productive of a sensible change in the mean annual temperature, yet such a modification in the distribution of heat among the seasons may be produced, as will greatly influence vegetation.

The unqualified decision of this question, as exhibited by Lyell, in the following quotation from his "Principles of Geology," is unsustained by any well observed facts:—"In the United States of North America, it is *unquestionable* that the rapid clearing of the country has rendered the winters *less* severe, and the summers less hot; in other words, the extreme temperatures of January and July have been observed from year to year, to approach nearer to each other. Whether in this case, or in France, the mean temperature has been raised, seems by no means as yet decided; but there is no doubt that the climate has become, as Buffon would have said, 'less excessive.'"

Contrary to Mr Lyell's opinion, one effect of clearing the country is, doubtless, to distribute the temperature of the year *more unequally*, thus rendering the seasons more variable; and hence causing, by the exposure of forests to spring frosts, a serious inconvenience, which has been experienced both in this country and in Europe. The reason of late and variable springs, under these circumstances, may be explained by reference to the fact, that, while the earth, clothed with forest and covered with snow, is never frozen, and hence sprouts forth its vegetation as soon as the snow is dissolved in spring; the earth in an open country, on the other hand, requires, after the snow is melted, to be thawed, thus rendering latent for several weeks a great quantity of caloric. This affords an explanation of the changes of climate referred to by Jefferson, Rush, and Williams. If, indeed, the mean annual temperature of Vermont has risen, according to Dr Williams, 10° or 12° within a century and a-half, it must surely have had an intolerable climate, when our ancestors landed on the rock of Plymouth; and, upon the same principle of a general increase of heat in our climate, the cultivation of the olive and the fig, since the first settlement of our country, ought to have advanced as far northward as Pennsylvania, if not to Vermont itself!

Dr Webster devotes some ten pages in his first essay, to the question of the cold of American winters; and he arrives, from a most extensive investigation of historical facts, at the conclusion, "that the winters have been from the first settlement of America variable, now mild, now severe, just as they are in the present age." A leading object with him is to shew the errors of Dr Williams, who having maintained that the mean temperature of Italy has increased 17°, wished to establish some analogous change in our own climate since its occupation by Europeans; and Dr Webster proves most conclusively, that "if Dr Williams is unfortunate in his facts, he is still more so in his reasonings and deductions.

As respects a supposed change of climate in the United

States, the quotation of a single passage from Dr W.'s essay must here suffice. According to John Megapolensis, a Dutch clergyman, who resided at Albany just two centuries ago, " the summers are pretty hot, and the winters very cold. The summer continues till All Saint's Day (Nov. 1), but then the winter sets in, in the same manner as it commonly does in December, and freezes so much in one night that the ice will bear a man. The freezing commonly continues *three months*; sometimes there comes a warm and pleasant day, yet the thaw does not continue; but it freezes again till March, and then commonly the river begins to open, seldom in February." Modern winters, according to this account, have not moderated. A common winter is still of *three months* duration, the Hudson, at Albany, usually freezing early in December, and continuing closed till March.

From this extensive and learned array of historical facts, Dr Webster's final conclusion, in his second essay, as regards the influence of clearing the country of its forests upon the seasons of the year, has a striking correspondence with our own deductions.

" From a careful comparison of these facts," he says, " it appears that the weather, in modern winters, is more inconstant than when the earth was covered with wood at the first settlement of Europeans in the country; that the warm weather of autumn extends further into the winter months, and the cold weather of winter and spring encroaches upon the summer; that the wind being more variable, snow is less permanent, and perhaps the same remark may be applicable to the ice of rivers. These effects seem to result necessarily from the greater quantity of heat accumulated in the earth in summer, since the ground has been cleared of wood, and exposed to the rays of the sun; and to the greater depth of frost in the earth in winter, by the exposure of its uncovered surface to the cold atmosphere."

It is thus apparent, that the opinion that the climate of the States bordering the Atlantic, on their first settlement, resembled that now exhibited by Fort Snelling and Council Bluffs, is wholly gratuitous, and unsustained by facts. No accurate thermometrical observations yet made in any part of the world, as already remarked, warrant the conclusion, that the temperature of a locality undergoes changes in any ratio of progression; but conversely, as all facts tend to establish the position that climates are stable. We are led to believe that the changes or perturbations of temperature to which a locality is subject, are produced by some regular oscillations, the periods of which are to us unknown. That climates are susceptible of melioration by the extensive changes produced on the surface of the earth by the labours of man, has been pointed out already; but these effects are extremely subordinate, compared with the modification induced by the striking features of physical geography—the ocean, lakes, mountains, the opposite coasts of continents, and their prolongation and enlargement toward the poles.

But even Malte Brun has ventured the assertion, that "France, Germany, and England, not more than twenty centuries ago, resembled Canada and Chinese Tartary—countries situated, as well as our Europe, at a mean distance between the equator and the pole." This illustration is certainly very unhappy; for rejecting the pretended antiquity of the Chinese—the fables in relation to Fohi and Hoang-Ti, the former of whom, we are told, founded the empire of China about five thousand years ago, we must, with Malte Brun, date its origin at least eight or nine centuries before Christ. China should, therefore, possess a milder climate than Europe, inasmuch as agriculture is represented to have been always in the most flourishing condition. As the practice of fallowing is unknown, almost the whole arable land is constantly tilled, and even the steepest mountains, cut into terraces, are brought under cultivation. Now, as this country still presents a climate as austere as that of Canada in the same latitudes, the conclusion is irresistible, that in proportion as the leading physical characters of a region are immutable in their nature, does error pervade the remark of Malte Brun—"That vanquished nature yields its empire to man, who thus creates a country for himself." A partial view of this question, indeed, not unfrequently leads to the most unwarranted conclusions. Any changes in the climate of the United States as yet perceived, are very far from justifying the sanguine calculations indulged in, a few years ago, by a writer, whose observations upon many other points are very valuable. "But there will, doubtless, be," he says, "an amelioration in this particular, when Canada and the United States shall become thickly peopled, and generally cultivated. In this latitude, then, like the same parallels in Europe at present, *snow and ice will become rare phenomena, and the orange, the olive, and other vegetables of the same class, now strangers to the soil, will become objects of the labour and solicitude of the agriculturist.*"

The fallacy of the opinion which ascribes the mild climate of Europe to the influence of agricultural improvement, becomes at once apparent, when it is considered, that the region of Oregon lying west of the Rocky Mountains, which continues in a state of primitive nature, has a climate even milder than that of highly cultivated Europe in similar latitudes; and, again, China, situated like the United States on the eastern coast of a continent, though subjected to cultivation for several thousand years, possesses a climate as rigorous, and some assert even more so, than that of the United States proper, on similar parallels.

It is thus sufficiently obvious, that the most diverse climatic phenomena on the same parallels find an explanation in the local influences of physical geography; and that, contrary to the opinion of Lyell, even the apparent anomaly presented by the mild climate of Europe, and by the climatic rigour of eastern North America, but confirms the harmony of these laws throughout the globe. But to explain this supposed exception to the general law, it has even been found necessary, as appears by a recent treatise on Comets by M. Arago, to have recourse to the action of one of these bodies.

"As soon as the northern regions of America," he says, "were discovered, it was remarked by the navigators, that at the same latitude they were much colder than those of Europe. This fact, which could not be satisfactorily explained by the astronomic theory of climates, engaged the attention of many naturalists, and among others, of Halley. According to that celebrated philosopher, a comet had formerly struck the earth obliquely, and changed the position of its axis of rotation. In consequence of that event, the North Pole, which had originally been very near to Hudson's Bay, was changed to a more easterly position; but the countries which it abandoned had been so long a time, and so deeply frozen, that evident vestiges still remain of its ancient polar rigour. A long series of years would be required for the solar action to impart to the northern parts of the new continent the climate of their present geographical position."

Fortunately, our knowledge of meteorology is now sufficiently advanced to enable us to laugh at this crude explanation of a change in the position of the terrestrial axis, resulting from the concussion of a comet.—*American Journal of Science and Arts*, vol. xlvii., No. 2, p. 221.

*Source of Fluorine in Fossil Bones.**

The analysis of fossil bones, communicated by MM. Girardin and Preisser to the Academie des Sciences, October 1842, afford the only well-detailed numerical results of the composition of this class of bones that we possess. The authors appear to have bestowed considerable care upon their research, and their estimate of the proportion of fluoride of calcium present was as follows:—

	Per Cent.
A metacarpal bone of a Bear from the cavern of Mialet,	1·09
Tusk of an Elephant, ...	2·64
Vertebra of a Plesiosaurus, . . .	2·11
The great bone of the Pœkilopleuron Bucklandii, .	1·50
Rib of an Ichthyosaurus, ...	1·02
Head of the same Ichthyosaurus, . . .	1·65
Bone of the Lamantin, from the tertiary formation in the environs of Valognes, ...	9·12

This fluoride would appear to form a distinguishing mark between fossil and recent bones, although Berzelius has found it to exist in these latter; and Marchand, in some recent experiments, mentions the same fact; still many other chemists have not succeeded in detecting it. MM. Girardin and Preisser suppose that it was owing to some accidental circumstances that Berzelius was enabled to discover it in the cases that he examined, they having, in no instance, found it, although carefully sought for. My experience tends to confirm Berzelius in his statement, having, in several cases, obtained most decided evidence of its presence in recent bones, but in very minute quantity. In many instances I failed to detect it, and attribute the failure more to the minuteness of the quantity than the total absence of it.

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* Extract from a communication made to the Association of American Geologists and Naturalists, at Washington, May 1844.

I would here remark, that in examining for fluorine in the ordinary way, by testing the effects of the hydro-fluoric acid (liberated by the action of sulphuric acid) upon waxed glass, with characters traced out, the process requires some precaution when the quantity present is supposed to be very small; for I have been able, in several instances, to obtain a permanent delineation of the characters traced, without the presence of fluorine. In these cases it is caused by the action of the vapours of either sulphuric or hydrochloric acid upon certain kinds of glass that contain a large quantity of metallic oxides, or upon glass the surface of which has been altered by the action of the air; there is, however, no apparent corrosion in these cases.

The existence of fluorine in fossil bones, and its doubtful, or, as some say, absolute, non-existence in those of recent animals, have induced MM. Girardin and Preisser to conclude that it did not belong originally to the bones of fossil animals, but has found its way there by infiltration after death; and they appear to have come to this conclusion without having examined the chemical character of the formations from which the various bones were taken.

I had an opportunity of throwing some light upon this subject, from the examination of two bones taken from the same calcareous deposit, and within two feet of each other, the one cellular, and the other compact. The cells of one of these bones were filled with small concretions of calcareous matter, evidently arising from the infiltration of some of the material forming the bed in which they lay. These concretions, it would seem, ought certainly to contain a portion of whatsoever matter had been infiltrated, as all infiltrations must have passed in together. These concretions, carefully detached from the bone, were examined especially for fluorine, but not the slightest trace was found; while, on the contrary, a very small quantity of the compact part of the same bone gave decided indications of the presence of this substance. This fact must certainly lead to the conclusion, that the fluoride of calcium in the body of the bone was not infiltrated; for, had it been otherwise, it would have been associated with matter known to be infiltrated, as the calcareous nodules.

The same cellular bone was examined as a whole—that is to say, without detaching the calcareous matter, in comparison with the compact bone from the same locality; and in the former there was found less fluoride of calcium than in the latter, contrary to what would have been the case had this fluoride been infiltrated.

Compact bone, . .	2·45 per cent. fluoride of calcium.
Cellular bone, . .	2·00 ... ...

The deposit from which these bones were taken was analyzed, and fluoride of calcium detected, but in very small quantity; and whether it arises from disintegrated osseous matter, or belonged originally to the calcareous remains forming this bed, is of no consequence; sufficient is it for us to know, that it has an organic origin, having been a part of either mollusca or vertebrated animals; and were it necessary to suppose that it could have existed in only one of those, I should unhesitatingly attribute its origin to the vertebrated animals, particularly on account of their abundant provision of phosphates. Bones were also examined that contained fluorine, when the deposit from which they were taken shewed no traces of this element.

Dr Daubeny has lately examined the question of the existence of fluorine in recent bones, and decided it in the affirmative.

It is not surprising that we should find the phosphates and the fluorides associated in the animal kingdom, for, in the mineral kingdom, fluorine is a very common attendant upon the phosphates, as, for instance, in the Apatites, Wagnerite, Wavellite, Urinite, &c.; and, I think, if we search the mineral kingdom, we shall not find so constant an association of any two elements as fluorine and phosphorus. All the phosphates of the alkalies and earths contain fluorine.

If, then, this element is associated with the phosphates, they must exist together in the soils, arising from the disintegration of the rocks containing those minerals, and the plants growing upon those soils would, upon taking up the phosphates, naturally appropriate the accompanying fluorides; which two classes of salts would subsequently pass to the same portion of the animal feeding upon those plants, namely, to the bones.

The reason why the existence of fluorine in recent bones is doubtful, may be owing to the fact, that the great mass of the phosphate of lime originally in the soil has, from various causes, disappeared, and with it the fluoride of calcium; and that the portion of this latter still remaining is so small, that, notwithstanding the double condensation that it undergoes, through the agency of plants and animals, it is not in sufficient quantity to come readily within the reach of our tests.—*American Journal of Science and Arts*, vol. xlviii., No. 1, p. 19.

On "Gutta Percha," a peculiar variety of Caoutchouc. By DOUGLAS MACLAGAN, M.D., F.R.S.E., &c. Communicated by the Royal Scottish Society of Arts.*

Gutta Percha is the Malayan name for a substance which is the concrete juice of a large forest tree, native of the shores of the Straits of Malacca, Borneo, and the adjacent countries. The tree yielding it is unknown botanically, all the information we possess regarding it being, that it is a large forest tree, and yields this product abundantly. We are indebted for our knowledge of it to Dr W. Montgomerie,

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* Read before the Society 23d June 1845.

H.E.I.C.S., whose spirited exertions to improve the cultivation of various articles of colonial produce at Singapore have obtained for him several distinguished marks of approbation from the Royal Society of Arts of London. For his communication regarding gutta percha, Dr Montgomerie received a silver medal from the Society.

This substance, in its crude state, differs, in many particulars, from common caoutchouc. It is of a pale-yellowish, or rather dirty-white, colour. It is nearly as hard as wood, though it readily receives the impression of the nail. It is very tenacious, and not at all elastic.

It seemed to me to be worth while to determine, whether or not this substance really was a variety of caoutchouc, and for this purpose I subjected it to the ordinary process of ultimate analysis, and obtained as its per-centage composition, carbon, 86·36; hydrogen, 12·15; the remainder, 1·49, was most probably oxygen absorbed from the air during the process employed for purifying it, as the substance, whilst heating on the vapour-bath, acquired a brown colour. The only analysis of common caoutchouc with which I am acquainted is that of Faraday, who obtained, carbon, 87·2; hydrogen, 12·8. The results are sufficiently near to warrant the conclusion, that the two matters in question are generically the same.

I found, also, that the gutta percha yields the same product of destructive distillation as the common caoutchouc. Without entering into details, I may briefly state, that both equally yield a clear, yellow, limpid oil, having no fixed boiling-point, and, therefore, being a mixture of different oleaginous principles. In both instances, the distillation proceeds most freely at temperatures between 360° and 390° Fahr., and seems almost stationary at 385°. Comparative analysis of similar portions of the two oils were made, and, as is already known of common caoutchouc, the products exhibit a constitution represented by the formula $C_{10}\ H_8$. The gutta percha thus appears really to be a modification of caoutchouc.

In its general properties it likewise shews a similarity to common caoutchouc. It is soluble in coal naphtha, in caoutchouc oil, and in ether. It is insoluble in alcohol and in water, and floats upon the latter.

Its most remarkable and distinctive peculiarity is the effect of heat upon it. When placed in water at 110°, no effect is produced upon it, except that it receives the impression of the nail more readily; but when the temperature is raised to 145° or upwards, it gradually becomes so soft and pliant as to be capable of being moulded into any form, or of being rolled out into long pieces or flat plates. When in the soft state, it possesses all the elasticity of common India-rubber, but it does not retain these properties long. It soon begins again to grow hard, and a short time, varying according to the temperature and the size of the piece operated on, regains all its original hardness and rigidity. A ball one inch in diameter was completely softened by boiling water in ten minutes, and regained its hardness completely in less than half an hour. It appears to be capable of undergoing this alternate softening and hardening any number of times without change of property.

It is also to a certain extent ductile. When soft it is easily torn across, but when hard it is very tenacious. A piece not an eighth of an inch in thickness, when cold, easily raised a weight of forty-two pounds, and only broke when half a hundred weight was attached to it.

From these properties, it seems capable of many applications in the arts. Its solution appears to be as well adapted as that of common caoutchouc for making waterproof cloth, and, whilst softened, it can be made into solid articles, such as knife-handles, door-handles, &c. The Malays employ it for the former of these, and prefer it to wood. A surgeon, furnished with a small piece, could easily, with the aid of a little hot water, supply himself with bougies or pessaries of any size or form.

[Dr M. exhibited a knife-handle, a walking-cane head, a riding-whip, and other articles, made of gutta percha.]

On Pseudomorphous Minerals. By Dr J. REINHARD BLUM.*

Dr Blum, in his interesting volume, divides all Pseudomorphs into two classes :—

Class I. Pseudomorphs produced by a partial change in the composition of the original mineral.

Class II. Pseudomorphs produced by a complete displacement of the original mineral by another.

In the first class, one or more elements are *removed*, *added*, or *introduced by substitution;* and these *three* modes constitute *three divisions* of this class of pseudomorphs. As an example of the *first* of these subdivisions, we instance Gay-Lussite changed to calc-spar by the *removal* of carbonate of soda and water; the *second*, anhydrite, changed to gypsum by the *addition* of water; the *third*, gypsum changed to calc-spar, by the *substitution* of sulphuric acid for carbonic acid.

In the *second* class, to form the pseudomorph, the original mineral is wholly removed and replaced by another.

The following catalogue contains the various examples enumerated by Dr Blum of these different kinds of pseudomorphs :—

CLASS I.

SUBDIVISION 1.

Pseudomorph.	*Form Imitated.*
Calc-Spar,	Gay-Lussite.
Kyanite,	Andalusite.
Steatite,	Hornblende.
Native Copper,	Red Copper-Ore.
Vitreous Silver,	Red Silver-Ore.

SUBDIVISION 2.

Gypsum,	Anhydrite.
Mica,	Pinite.
Antimony Bloom,	Native Antimony.
Anglesite,	Galena.
Specular Iron,	Magnetic Iron.
Brown Iron-Ore,	Specular Iron.
Malachite,	Red Copper-Ore.
Variegated Copper-Ore,	Vitreous Copper.
Copper Pyrites,	Vitreous Copper.

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* *Vide* the work entitled, " Die Pseudomorphosen des Mineralreiches," by Dr J. R. Blum. 8vo, pp. 378. Stutgard. 1843.

SUBDIVISION 3.

Pseudomorph.	*Form Imitated.*
Heavy-Spar,	Witherite, Baryto-Calcite, and Calc-Spar.
Calc-Spar,	Gypsum.
Dolomite,	Calc-Spar.
Calcedony,	Datolite.
Jasper,	Hornblende.
Opal,	Augite.
Quartz,	Garnet.
Cimolite,	Augite.
Lithomarge,	Topaz, Felspar.
Kaolin,	Felspar, Porcelain-Spar, Leucite.
Mica,	Andalusite, Wernerite, Tourmaline.
Prehnite,	Analcime, Leonhardite.
Talc,	Kyanite, Felspar, Pyrope.
Steatite,	Dolomite, Spinel, Quartz, Andalusite, Topaz, Felspar, Mica, Wernerite, Tourmaline, Staurotide, Garnet, Idocrase, Augite.
Serpentine,	Augite, Hornblende, Chrysolite.
Chlorite,	Garnet, Hornblende.
Hornblende,	Augite.
Green-Earth,	Augite.
Pyrolusite,	Manganite.
Hausmannite,	Manganite.
Antimony Bloom,	Gray Antimony.
Antimony Ochre,	Gray Antimony.
Antimony Blende,	Gray Antimony.
Bismuth Ochre,	Needle-Ore.
Minium,	Galena, White-Lead Ore.
Pyromorphite,	Galena, White-Lead Ore.
White-Lead Ore,	Galena, Anglesite, Leadhillite.
Molybdate of Lead,	Galena.
Red Iron Ore,	Pyrites, Cube Ore, Spathic Iron.
Brown Iron Ore,	Ankerite, Pyrites, White Iron Pyrites, Scorodite, Cube Ore, Spathic Iron.
Göthite,	Pyrites.
Pyrites,	Mispickel.
Green Vitriol,	Pyrites.
Pseudotriplite,	Triphyline.
Wolfram,	Scheelite.
Cobalt Bloom,	Smaltine.
Black Copper,	Vitreous Copper.
Malachite,	Azurite, Copper Pyrites.
Chrysocolla,	Copper Mica and Red Copper Ore.

CLASS II.

Common Salt,	Dolomite.
Anhydrite,	Common Salt.
Gypsum,	Common Salt.
Polyhalite,	Common Salt.
Carbonate of Strontian,	Gypsum.
Quartz,	Heavy-Spar, Fluor-Spar, Gypsum, Calc-Spar, Baryto-Calcite, Dolomite, Scheelite, Galena, White-Lead Ore, Specular Iron, Pyrites, Spathic Iron: as *Prase,* Calc-Spar: as *Calcedony,* Heavy-

Pseudomorph.	*Form Imitated.*
	Spar, Fluor-Spar, Calc-Spar, Dolomite, Pyromorphite: as *Carnelian*, Calc-Spar, Mica, Spathic Iron: as *Semiopal*, Calc-Spar.
Lithomarge,	Fluor-Spar.
Felspar,	Calc-Spar.
Meerschaum,	Calc-Spar.
Pyrolusite,	Calc-Spar.
Hausmannite,	Calc-Spar.
Manganite,	Calc-Spar.
Psilomelane,	Heavy-Spar, Fluor-Spar, Cube Ore.
Calamine,	Fluor-Spar, Calc-Spar.
Electric Calamine,	Fluor-Spar, Calc-Spar, Dolomite, Galena, Pyromorphite.
Tin Ore,	Felspar.
White Lead Ore,	Heavy-Spar, Fluor-Spar.
Peroxide of Iron,	Fluor-Spar, Calc-Spar.
Brown Iron Ore,	Heavy-Spar, Fluor-Spar, Calc-Spar, Dolomite, Quartz, Comptonite, Blende, Galena, Pyromorphite, White-Lead Ore, Red Copper Ore.
Pyrites,	Heavy-Spar, Calc-Spar, Quartz, Brittle Silver Ore, Red Silver Ore.
White Iron Pyrites,	Brittle Silver Ore.
Spathic Iron,	Calc-Spar, Dolomite.
Malachite,	Calc-Spar, White-Lead Ore.
Chrysocolla,	White-Lead Ore.

To this catalogue we may add the following:—

Green Earth, under the form of Haydenite.
Chlorophyllite and Fahlunite, under the form of Iolite.
Rensselærite, under the form of Augite.

Pseudomorphous changes in the simple salts, produced by a replacement of the acid or base, admit of easy explanation upon the most common principles of chemistry. Such is the change of carbonate of lime to sulphate of lime (gypsum) by the expulsion of the weaker acid (carbonic) by *sulphuric acid*, and we need only look to some decomposing pyrites (sulphuret of iron) for a source of this acid. Other changes are more difficult of explanation. We shall now notice some of the more interesting facts in Dr Blum's work.

Gypsum with the form of Anhydrite.—Large deposits of anhydrite have undergone this change to gypsum. In the Canaria Thal, a bed of this mineral in mica-slate consists of gypsum wherever it is exposed. At Bex, in Switzerland, the same fact is observed; the unaltered anhydrite is invariably obtained by digging down sixty or one hundred feet from the surface. The same has been observed by Alberti in the Muschelkalk of Germany. This change consists merely in the addition of water, and the facts cited evince that it takes place principally through atmospheric agency.

Chalcedony with the form of Datholite.—According to Levy, the chrystallized chalcedony from Hay-Tor, Devonshire, called Haytorite, is altered Datholite. The change consists in the removal, from the compound, of lime, boracic acid, and water, and the addition of silica.

Lithomarge with the form of Topaz.—Topaz altered to lithomarge occasionally occurs in Brazil in a talcose slate, and a Siberian specimen has been observed with a milk-white exterior, owing to a similar change. The change consists in the removal of fluoride of aluminum and the addition of water.

Kaolin with the form of Felspar.—This very frequent change requires only the most common agents. Forchammer has shewn that heated water, even when pure, will cause the alteration; but Dr Blum is disposed to consider carbonic acid as usually present when it is in progress, and alludes to instances of regions of carbonated waters where the process goes on with unusual rapidity.

Mica with the form of Andalusite.—Crystals of andalusite have been observed changed wholly to a light-coloured mica, and others in which this change was but partially complete, the ends being mica and the middle andalusite. In the change, silica and potash are added.

Mica with the form of Scapolite.—Dr Blum describes a crystal of scapolite altered to mica, from Arendal, which is three inches long, and consists of an aggregate of mica scales. Along with the altered scapolite there is a soft talc-like mass, which also appears to have been produced by the alteration of this mineral,

Mica with the form of Tourmaline.—Crystals of tourmaline, consisting of mica, or with mica terminations, have been observed in Saxony, at Heidelberg, near Rozena, and elsewhere. That at Rozena is a red tourmaline, altered to lepidolite or reddish mica. The micarelle or micanite of Neustadt is shewn by Dr Blum to be altered tourmaline, some of the crystals having distinctly the form of that mineral.

Prehnite with the form of Analcime.—These pseudomorphs occur at Dumbarton, at Molignon in the Tyrol, and near Wolfstein in the district of the Lower Rhine. At the last locality they are associated with calc-spar and datholite in diorite. The datholite appears to have been partially acted upon at the time of the change, and is supposed to have given the lime to the forming prehnite.

Talc with the form of Kyanite.—These pseudomorphs have been observed at Wustuben, in the Fichtelgebirge. The edges of the crystals are rounded, and the surface is covered with a thin crust of talc; within they are a fine-grained aggregate of talc, possessing the softness and other characters of this mineral. The change consists in the substitution of magnesia for alumina.

Talc with the form of Felspar.—This pseudomorph has been found at the tin-mines of Altenberg in Saxony, associated with quartz, specular iron, and light-coloured talc. The felspar crystals consist of talc in fine foliated grains; they have a rough drusy surface, yet tolerably sharp edges.

Steatite with the form of Hornblende.—The Pargasite occurring in granular limestone at Pargas, Finland, is sometimes altered to steatite of a greenish colour. From the nature of the crystals, Dr Blum infers that the change commenced at the centre where it is most complete. It requires the removal only of the lime.

Steatite with the form of Quartz.—These pseudomorphs occur at Göpfersgrün. The form and striæ of the planes are well preserved. Where the change is partial, the quartz has become white, and without lustre; when complete, all the characteristics of the quartz are lost except the external form, and a soft earthy steatite has taken its place.

Dr Marx has suggested, that the magnesia that caused the change came from the bitter spar; but Dr Blum urges, in opposition to this view, that the magnesia in this mineral is in small quantities, and still remains in the bitter spar pseudomorphs, and inclines to the opinion on the contrary that the quartz afforded the silica that has altered the bitter spar. Several instances are referred to of massive and columnar quartz in the same region altered to steatite, and also foliated quartz interlaminated with steatite in consequence of a partial change. The striæ of the surface, still retained, shew that the whole was originally quartz.

At Göpfersgrün the gangue is a steatitic slate, lying between mica-slate below, and probably granular limestone or dolomite above; and there is every reason to believe that the steatitic rock is an altered mica-slate. After passing through twenty-four to thirty feet of the decomposed slate of the surface, the steatite first appears, and continues for fifty or sixty feet; below this the pseudomorphous quartz and bitter spar are obtained both in crystals and massive. Near by this the mica-slate becomes penetrated with granular limestone. At Hohlenbrunn the same granular limestone contains, besides masses of quartz, octahedrons of fluor-spar. These facts are urged by Dr Blum as evidence that the same process which produced the steatitic pseudomorphs changed the rock containing them from a mica-slate. The steatite replacing the quartz is quite pure; while that of the slate is brown and impure, from the iron in the mica, and looks like a clay-slate.

The serpentine of Monte Rosa affords similar pseudomorphs. Dr Blum describes a geode in his collection, in which the terminal angles are steatite, and the exterior of the crystals has become yellowish-white, or brownish-red, without affecting the sharpness of the edges or smoothness of the surfaces. The specimen is from Olmutschen, in Mähren.

Similar crystals have been found by Professor Emmons in the serpentine of Middlefield, Mass., and by Dr Fowler, in the granular limestone of Newton, N. J.

Pimelite is supposed by Dr Blum to have often originated by similar changes; and also Meerschaum at Hrubschnitz, in serpentine, have often, he states, a nucleus of *firestone*, (a coarse kind of opal occurring there in similarly shaped nodules), while others are wholly Meerschaum. Dr Blum suggests, that the silica that has passed off in the change is found in the opal that occurs at the same locality, and finds proof of this in the forms and position of the opal.

Steatite with the form of Andalusite.—Pseudomorphs of this kind have been described by Von Leonhard, and Goldfuss and Bischof. The change is a simple replacement of the alumina by magnesia.

Steatite with the form of Mica.—At Monzoni, tabular crystals of mica changed to steatite occur along with steatitic spinels. At Brünn, the same occurs in a granitic rock, the whole of which is altered—the felspar to kaolin, and the brown mica to a yellowish-green steatite. The Thiersheim granite affords similar changes.

Serpentine, with the form of Augite.—Near Schwarzenberg in Saxony, a serpentine occurs with the form of Sahlite, which was taken for crystallized serpentine, until afterwards shewn to have the angles of the latter mineral. A black augite, altered to serpentine, has been found at Fahlun.

Serpentine, with the form of Hornblende.—Crystals of actinolite, altered to serpentine, have been observed near Presnitz, in Bohemia, and hornblende crystals at Eastin, New Jersey. The greywacke of Planen, Weischlitz, and Geilsdorf, affords other localities of these hornblende pseudomorphs.

Serpentine, with the form of Olivine.—Quenstedt has shewn that crystals of serpentine from Modum in Norway have the form of olivine, and in Poggendorf's Annalen for 1835, explained the chemical changes passed through in turning olivine into serpentine. Some of the crystals are four inches long; they usually have rounded angles and little lustre.

Tamnau has objected to this origin of these serpentine crystals, on the ground of the extensive changes that must have been required in producing the wide-spread beds of serpentine; and also that crystals of olivine of the size of these crystals of serpentine had not been observed. Other reasons are brought forward by him for doubting Quenstedt's view, but they appear unsatisfactory. Breithaupt has long since suggested, that serpentine may be an altered hornblende rock or diorite; beds of diorite in Saxon Voigtland, sometimes have the characters of serpentine, and there is good reason for believing, that all serpentine, as well as its contained minerals, is actually of metamorphic origin. The occurrence of so many pseudomorphs, consisting of steatite, an allied mineral, favours this view. The exact imitation and dull lustre, leave little doubt that they are actually altered crystals. Besides, instances of olivine altered to a greenish or brownish-yellow steatitic mineral have been described by Reuss, as occurring in Bohemia and elsewhere.

Hornblende, with the form of Augite.—The uralite of Rose, a mineral with the form of hornblende and cleavage of augite, Dr Blum shews to be an altered hornblende. He mentions various instances of the singular mixture or union of the two minerals, which he explains by supposing this change to have been partially carried out. He describes druses of crystals from Arendal, Norway, which have the form of hornblende, but nothing of its texture within, and which he concludes, therefore, to be pseudomorphs of hornblende. Other examples of this kind of pseudomorph are said to occur in porphyry near Miask, near Predazzo in the Tyrol, at Mysore in Hindostan, and elsewhere. Dr Blum also mentions a greenish-white augite from Orange County, New York, in the Leonhard collections, which he supposes to have undergone the same change from hornblende. This is indicated both by its structure and angles.

The metamorphosis in the composition producing this change is, in general, an increase of the bases. The varieties of the two minerals differ so much, that it becomes difficult to represent the change by means of the formulas.

Chlorite, with the form of Hornblende.—At Greiner, in the Tyrol, there is a deposit of mica-slate situated between gneiss and hornblende rock; and the hornblende is changed to a leek-green and dark-green chlorite, some of the folia of which are an inch or more broad. Rose describes similar facts, and mentions some crystals of hornblende that were chlorite externally, to a line or more in depth.

Brown Iron Ore with the form of Pyrites.—The change of pyrites to brown iron ore appears to be a very common one in nature, and is in progress at the present time. It consists in the removal of the sulphur from the pyrites (sulphuret of iron), and the substitution of oxygen and water, and is supposed to take place generally by the formation, first, of a hydrated sulphate of iron, the sulphur and iron each uniting with oxygen, and then, following this, a removal of the sulphuric acid by some alkali or earth in the vicinity. Instances are given of gypsum, thus produced by this acid, combining with the lime of the gangue. A more direct mode, without the change to a sulphate, is as follows:—The water present gives hydrogen to the sulphur, to form sulphuretted hydrogen, and oxygen to oxidate the iron; and with the oxide thus formed, other portions of water combine and produce the hydrate of iron in brown iron ore. In this process some sulphur is set free, and thus Dr Blum accounts for the incrustation of sulphur often found with decomposing pyrites, or in cavities originally occupied by this mineral.

The change producing those pseudomorphs, commences with the exterior; and it is quite common to find crystals with a thin incrustation of brown iron ore. Cubes, pentagonal dodecahedrons, and compound crystals, thus altered, are of frequent occurrence.

Among pseudomorphs, in which there is a total change in the constitution of the mineral, or a complete replacement of the same by another, there are two distinct modes of formation. The substitution takes place either during the removal of the original mineral, or, afterwards, by infiltration into its mould.

Of the latter mode, are, probably, as our author suggests, the pseudomorphs of anhydrite, gypsum, and polyhalite, with the form of common salt. The cubes of salt embedded in clay were removed by solution, and the place afterwards occupied by the infiltrating anhydrite, gypsum, or polyhalite.*

Of the former mode, are most of the pseudomorphs of quartz. Implanted crystals are thus altered when there are no moulds to be filled up.

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* The hopper-form clay-crystals found in the red marl of the Onondaga salt region, appear to be casts of hopper-form crystals of salt. These hollow pyramidal crystals were embedded in the clay (after being produced by the evaporation of salt water over the clay), and subsequently being dissolved out, left clay casts of their singular forms.

Another kind still, proceeds from the incrustation of crystals by another mineral, and their subsequent removal, leaving a thin hollow mould, with the external and internal form of the original crystal.

The various siliceous pseudomorphs are the most numerous and most interesting of this class. We have already enumerated them on page 242. The change is often complete through the crystal, the whole being altered to quartz. In other instances, the interior is vacant, or consists of the original mineral still unaltered. Crystals of fluor-spar, consisting of quartz, except a small fluor nucleus, are noticed by Blum. An instance is given by our author of altered calc-spar, in which the silica penetrated between the laminæ, forming a series of plates, and the remaining lime afterwards removed, left a cellular crystal with the general structure of the calc-spar. Their surfaces are generally rough or drusy, but sometimes are smooth, with the edges and angles sharp.

Besides the siliceous pseudomorphs, others of special interest, are those of felspar, with the form of calc-spar; silicate of zinc, with the form of calc-spar, and other minerals, above enumerated; of tin ore, with the form of felspar; peroxide of iron, with the form of calc-spar; brown iron ore, with the form of heavy-spar, fluor-spar, calc-spar, bitter-spar, quartz, &c.

The account of the changes of calc-spar to silicate of zinc, are interesting. When complete, the crystals consist wholly of granular silicate of zinc, with the interior forms, but never hollow. When less complete, zinc has incrusted and penetrated between the cleavage, laminæ of the lime, some of the latter being yet included. The silicate of zinc, which has here produced those pseudomorphous changes, appears to have, in part, proceeded from zinc-blende in the vicinity. Dr Blum supposes the first change to have been to sulphate of zinc, and then, through the action of siliceous waters, to a silicate, the sulphuric acid going, at the time, into combination with lime, and forming gypsum, a mineral observed by Zimmermann at the locality.

The pseudomorphs of *tin ore with the form of felspar*, come from the mine of Huel Coates, in Cornwall. They are mostly compound crystals, with a rough exterior, and consisting of granular tin ore, more or less mixed with granular quartz. Anker has described similar pseudomorphs, which are tin ore in the middle, and pure unaltered felspar at each end. Blum makes mention of other specimens from St Just and Huel Coates, which consist of granular quartz, and white mica, with disseminated tin ore. These specimens are found in the vicinity of the tin lodes of Cornwall, and appear to shew, as Dr Blum states, that the gangue of the ores was produced by the same process that formed these pseudomorphs. Von Dechen, in an account of the tin ore occurring in the syenite and felspar porphyry of Altenberg, mentions that the rock adjoining the lode is altered to hornstone mixed with granular quartz, and contains disseminated tin ore; and also occasionally includes masses of quartz and mica with more or less tin.—*J. D. D. American Journal of Science and Arts*, vol. xlviii., No. 1, p. 69.

Observations on Pseudomorphism. By J. D. Dana.

Notwithstanding the exact balancing of chemical formulas which we find through Dr Blum's work, there is yet much mystery with regard to the origin and formation of mineral pseudomorphs. The elements removed and the amount added, may be laid down with mathematical exactness, but that the change has consisted in precisely such a removal and addition, is by no means sure. Moreover, in searching for the causes of pseudomorphous changes, it appears to have been too much the method to look for distinct causes for each separate instance of pseudomorphism; whereas we deem it probable that some few general principles will yet be ascertained that will embrace and explain the whole subject.

Although we cannot hope to remove all the obscurity that rests upon this subject, yet we may venture to offer some considerations in its elucidation, such as appear to result from the known causes acting in nature, and the facts that have passed in review. Could we believe, with some late chemists, in the transmutation of the elements, we should consider this a fruitless subject of investigation, since, in the midst of the many possibilities which an hypothesis creates, we should hardly know which to choose. But the received principles of chemical science are believed sufficient for these explanations, without the aid of such speculations.

Viewing pseudomorphs with reference to their origin, we may make the following distribution of them; those produced,

1. *By Infiltration;* in which a cavity previously occupied by a crystal, is refilled by some other mineral. A cubic crystal of salt in clay is removed by percolating water, and the cavity afterwards filled with gypsum. In this there is nothing chemical; it is simply a mechanical deposition into a ready formed mould.

2. *By Incrustation;* in which a mineral incrustation covers a crystal, which crystal is subsequently removed by some process of solution. Like pseudomorphs by *infiltration*, this process is mechanical—a simple deposition of foreign matter around a crystal. The process by which the original crystal was removed is a separate inquiry, and one of much interest.

3. *By Replacement;* in which one mineral gradually replaces another, assuming, at the same time, its form, without any interchange of elements; for example, the siliceous cubes, pseudomorphs of fluor-spar, in which silica replaces the original fluor, and has taken on its cubic form. Here the process is, in a certain sense, chemical, and is wholly different from the simple act of deposition, by which the first two kinds of pseudomorphs above mentioned were formed.

These three so different classes of pseudomorphs are included together by Dr Blum, and constitute his second section, headed "Verdrangung-Pseudomorphosen," or pseudomorphs by expulsion.

4. *By Alteration;* in which some of the elements of the

original mineral are removed, or exchanged, or others added. Thus anhydrite becomes gypsum by the addition of water; felspar becomes kaolin by the addition of water, and removal of potash and some silica. This class includes all the pseudomorphs in Dr Blum's first section, his "Umwandlungs-Pseudomorphosen," or pseudomorphs by exchange. The change producing them is wholly chemical, being the result of chemical affinities.

Dr Blum's subdivision of this class, although convenient for description, is objectionable when considered with reference to the formation of pseudomorphs. The change of hornblende to steatite, placed in his *first* subdivision, is undoubtedly due to the same cause that produced the change of augite, felspar, mica, &c., to steatite, given in his *third* subdivision; and the first-mentioned should be placed, in a natural arrangement, near the latter. The following distribution is proposed, but much further investigation is required before it can be fully carried out:—

a. Pseudomorphs that are formed at the ordinary temperature, and result from atmospheric agents.

b. Pseudomorphs that proceed from the same and other agents, but only under the action of heat.

5. *By Allomorphosm;* in which a substance, under one of its dimorphous forms, changes to the other without altering the external form.

The processes by which pseudomorphs of the first two kinds (by *infiltration and by incrustation*) have resulted, are too simple to require further remark. We shall allude, on a following page, to the causes that may have been instrumental in removing the crystals.

PSEUDOMORPHS BY REPLACEMENT,

The pseudomorphs by *replacement,* are considered the most singular of altered crystals. In some way, the substance of a crystal is entirely removed, and, at the same time, is replaced by some other material, without changing an angle or plane. Yet these altered crystals appear to be little more singular in their mode of formation than the common petrifaction of wood. The particles of wood, as they pass off, are immediately replaced by the petrifying material, and so neatly as to leave every fibre still distinct after the change to stone. There is only this difference in the process—gradual decomposition removes the wood; while, in most of these pseudomorphs, some solvent or chemical agent is required to carry off the original mineral; and this distinction is more apparent than real.

The nature of the solvent or chemical agent is the unexplained mystery with regard to these pseudomorphs.

It is a fact worthy of special consideration, that a large majority of these altered crystals are siliceous. The silica of which they are constituted, we may safely conclude to have been in solution, and some siliceous fluid, therefore, must have been operating upon them during the change. Was this fluid hot or cold? Was it a simple solution of silica, or were other salts present? A solution of silica, whether resulting from the decomposition of felspar at the ordinary temperature, or whether, proceeding from submarine volcanic action, will, in either case, contain other substances. The alkali of the felspar, potash, or soda, passes off with the liberated silica; and, in the latter case, the heated waters, if marine, will include both soda and magnesian salts. Such are some of the elements that may have been active in producing these changes. If we may suppose the solution to have been heated, still more efficiency is given to the chemical agents it may contain, through the dissolving power of hot water itself.

But do we need other decomposing chemical agents besides a heated solution of silica in water? Is not the process one of removal by simple solution, and a contemporaneous substitution of silica? A crystal of calc-spar in a hot siliceous fluid, being exposed to solution from the action of the water alone, the silica, depositing itself gradually on a reduction of temperature, takes the place of the lime as soon as set free. This appears to be the process by which such changes have taken place. Every silicified fossil is an example of this pseudomorphous process; and, instead of its being confined to the few silicified crystals, instances are distributed through a large part of the sedimentary formations of all ages.

There appears to be no union of the silica with the liberated lime, since, although silicified fossils are so common, we find nothing of the *silicate of lime*, which would thus result and shew itself, either in the adjoining rocks, or the fossil itself.

The process, then, is probably a mere solution, and an attending substitution. There appears to be something in the chemical forces excited among the molecules, by the process of solution, when very slow and gradual, which leads the molecules of any body that may be passing at the time from a liquid state, to take the place successively of each molecule that is removed; and thus it is that the original form to the minutest stria is so exactly assumed by the substituting mineral.

Moreover, as a liquid, saturated with one salt, will not take up as much of another, the solution of the lime in the case under consideration may be the occasion of the deposition of silica in its place.

Fluor-spar, and other minerals, may underge this change in the same manner. Heavy-spar is stated in our chemistries to be entirely insoluble; yet there is no doubt that many of its crystallizations in nature have taken place from solution,—cavities in crystals of this mineral have contained a fluid which, on evaporation, afforded crystals of barytes. We are not, therefore, authorised to assert the entire insolubility of heavy-spar under all circumstances of *heat* and *pressure*. This mineral is found occupying cavities, and filling veins in sedimentary limestones, that do not shew the least trace of the effects of heat. We must suppose heated waters acting under pressure to have been solvent in these cases, but not heated so highly as to crystallize the sedimentary limestones.

Simple solution without decomposition appears to be the most probable view of the change, as in the case of the silicified fossils. The same explanation embraces all the various siliceous pseudomorphs, though so different in composition and character. We may suppose carbonic acid to be present to aid in carrying off the calc-spar, in order to produce the siliceous pseudomorph; but this explanation would extend to sulphate of barytes, fluor-spar, &c. Besides, it appears improbable that the siliceous solutions that have altered so many calcareous fossils should have contained carbonic acid.

The reason that silica is so common in pseudomorphs, as well as so common a material in the constitution of fossilized wood and shells, consists in its ready solution in water at high temperature under pressure, whenever an alkali is present, as is seen in many volcanic regions; and its ready deposition again as the waters cool. Soluble minerals cannot, of course, form pseudomorphs of this kind; and lime, which is slightly soluble, is a rare material for this purpose, because it is not as readily deposited under the circumstances supposed. Yet we have calcareous petrifactions, which are formed from cold concentrated solutions of carbonate of lime in carbonated waters; the lime being deposited as the waters evaporate, and the excess of carbonic acid passing off.

Admitting the preceding views, we comprehend also the formation of other common pseudomorphs in this division, consisting of *brown iron ore.* This mineral acts like silica in depositing itself in the place of the successively removed particles of the original mineral. The beds of this ore have proceeded evidently from more or less perfect solutions, as the stalactitic forms of the mineral prove. And should any process remove the material of a crystal exposed to such a solution, this iron ore might gradually take its place. It has not the power, like silica, of decomposing carbonate of lime under any circumstances; and, consequently, it is inefficient, except in making itself simply a substitute for the removed mineral.

The pseudomorphs of *peroxide of iron* are often siliceous within, and it seems that the waters containing the iron were also siliceous. The ironstone petrifactions of wood, so common in some formations, have often the hardness of quartz. These facts, in connection with this—that the iron is the anhydrous peroxide instead of the hydrous brown iron ore—afford evidence that the petrifying waters were siliceous, and heated to a high temperature, the iron ore not being hydrous on account of the latter condition.

The change of *datholite* to *calcedony* (Haytorite), we are inclined to place in the same category with the above, although considered by Dr Blum an instance of *alteration* rather than *replacement.*

PSEUDOMORPHS BY ALTERATION.

The pseudomorphs by alteration, although seemingly rendered more intelligible by means of the chemical formulas than those we have just considered, are yet, in many cases, more difficult of satisfactory explanation.

Before proceeding with our remarks upon them, we would direct attention to the small number of minerals constituting these pseudomorphs, as shewn in the catalogue given in pp. 241, 242. Of earthy species there are only the following:—Calc-spar, gypsum, heavy-spar, dolomite, mica, kyanite, hornblende, kaolin, cimolite, prehnite, the magnesian minerals, steatite, talc, serpentine, and chlorite, and rarely quartz, with some of its varieties, and opal.

For the elucidation of these pseudomorphs, we have above distributed them into—

I. *Those formed at the ordinary temperature ; and,*

II. *Those requiring an elevated temperature.*

1. *Pseudomorphs formed at the Ordinary Temperature.*

Pseudomorphs of the first of these divisions result from the agency of the elements of the atmosphere in connection with moisture ; but the process is usually more or less dependent on foreign substances in solution in water, such as its common impurities, *salts of lime*, *carbonic acid*, &c., and in many instances the results of mineral decomposition in the vicinity, aid in producing the change. They may be farther subdivided as follows:—

1. Those resulting from atmospheric agents and moisture.
2. Those produced by the agency of gases, salts, or acids, contained in the water or atmosphere.

The following are a few examples in illustration of the first of these subdivisions.

Anhydrite to Gypsum.—A simple addition of atmospheric moisture.

Specular Iron to Brown Iron Ore.—The same.

Red Copper Ore to Malachite.—Combination with the carbonic acid of the atmosphere and moisture.

Galena to Sulphate of Lead.—A simple oxidation of the sulphur and lead.

Pyrites to Brown Iron Ore.—By the decomposition of water the sulphur forms sulphuretted hydrogen, and the iron is oxidized; water then combines with the oxide formed. (*Vide* p. 248.)

Pyrites to Red Oxide of Iron.—Probably the same as the last, except that the oxide formed does not combine with water.

Carbonate of Iron to Brown Iron Ore.—From contact with moisture, the surface of the carbonate of iron is dissolved; and then, on subsequent evaporation, the carbonic acid passes off, the iron becomes peroxidized, and, by uniting with other portions of water, forms the resulting brown iron ore. This process, repeated for a period of time, changes the crystals throughout.

The evaporation of chalybeate waters, containing carbonate of iron in solution, illustrates this process; carbonic acid escapes, as above described, and the iron falls as a hydrated peroxide, or brown iron ore. It is a common laboratory experiment.

Galena to Minium.—Similar to the change of pyrites to brown iron ore, except that the resulting oxide does not combine with water. A hydrated oxide of lead has not been observed in nature.

Galena to Carbonate of Lead.—Similar to the last, except that the oxide of lead combines with carbonic acid.

Carbonate of Lead to Pyromorphite.—Phosphates so frequently result during animal decomposition, that we deem it quite probable that this pseudomorph might have received its phosphoric acid from this source.

Felspar to Kaolin.—This change is attributed to the disposition of the potash to combine with water and carbonic acid. By this means the equilibrium of the compound is disturbed. New attractions then begin to work among the remaining elements, and kaolin is the result; at the same time, those elements capable of solution passing off which do not enter into the combination.

This example affords the general theory for many pseudomorphs of the more complex mineral species. *Some one element or more, by the influence of external agents, enters into new combinations, and is removed; this disorganises the original compound, and leaves the remaining elements free to combine anew; such as are capable, consequently, unite by their affinities, either alone or with water (or other chemical agents present); the excess, if any, and soluble, passes off in solution.*

It is not impossible that the change of felspar takes place without the agency of carbonic acid, by means of moisture alone. If so, we would suggest whether the moving cause in the change rests not in the tendency of silica, potash, and water to combine, instead of the attraction between potash and carbonic acid? The silicate of potash may thus be removed: this silicate would, however, be soon decomposed by the carbonic acid of the atmosphere.

We cannot affirm but that some alumina also passes off with the hydrous silica of potash, and that a *zeolite* as well as free silica is liberated; for the result might still be the same, proceeding, as it does, from the chemical affinities between the remaining elements and water.

Without dwelling longer on this branch of the subject, we proceed to the next subdivision, mentioning a few examples only:—

Carbonate of Barytes to Sulphate of Barytes.—The change of carbonates to sulphates, when within reach of a decomposing metallic sulphuret, or by the action of waters containing sulphuretted hydrogen in solution, is well understood.

Sulphate of Lead to Carbonate of Lead.—Among the salts of lead, the carbonate is the least soluble, and consequently, as chemistry has shewn, any of the insoluble salts of lead may be decomposed by soluble carbonates. Carbonate of soda effects the change readily in sulphate of lead, when the two are heated together. Is it not possible that carbonate of lime, in the slow process of nature, may occasion the same change, although not aided by heat?

Tungstate of Lime to Tungstate of Iron (Wolfram).—Probably due, by a double exchange, to the slow action of nascent sulphate of iron, proceeding from the decomposition of pyrites in the same rock; but whether heat be required or not, as in the process of the laboratory, we cannot say.

2. *Pseudomorphous changes requiring an Elevated Temperature.*

Magnesian Pseudomorphs.—The magnesian pseudomorphs appear to fall within this division. The magnesian minerals constituting them are talc, including the variety steatite, saponite or hydrous steatite, serpentine and chlorite. In the change of felspar to talc, magnesia, by its affinity for silica, expels alumina, and, at the same time, the other elements of felspar that cannot enter into the new magnesian compound pass off. The same takes place in the change of mica, kyanite, augite, &c., to talc. The general theory of the process corresponds, then, with that already stated at top of page 259.

Magnesia, either in solution or in the state of vapour, has acted upon the mineral and rocks that have undergone this change.

The idea of *magnesia in vapour* is an assumption, as yet unauthorized by chemical science, except as a theoretical possibility. It may be *convenient* to summon the hypothesis to our aid, for the sake of an explanation; but, as far as facts have been ascertained, they stand against such a view. Many of the rocks so altered to magnesian *contain water;* evincing thus that they have not been subjected to that immeasurable degree of heat, which the fancy might call up for producing evaporation of this most fixed and infusible of the earths.

Magnesia compounds in solution are well known. Sea water is such a solution, and one that has existed, as geological facts testify, since geological changes commenced on the globe. And are not these pseudomorphs some of the effects resulting through its agency, when under the influence of volcanic heat? The view, we would here maintain, is the same already presented in a preceding volume of this Journal, namely, that the ocean waters, superincumbent, and penetrating the rocks, heated by igneous action from below, have been the medium through which those changes have been effected; aided by additional magnesia and other elements, which the heat and pressure would enable them to dissolve from the neighbouring rocks.

We cannot doubt, especially when we consider the vast pressure of an ocean, that these waters, besides overlying, fill up all open spaces or caverns between the layers of submerged rocks; and, probably, the whole substratum of the ocean, when not too compact, is throughout permeated by them. Submarine eruptions opening to the fires below, and sometimes ejecting lavas, would distribute heat around, and thus give the waters increased power in their action upon rocks. This cause, therefore, is sufficient in its energy, and sufficiently extended in its influence. It must have been in action ever since the earth had an ocean and internal fires, for it is a necessary effect of all submarine volcanic action. Wherever a trap-dike is to be found on the globe in a vein of porphyry, there have been heated waters, permeating and superincumbent, and under the pressure of an ocean intensely heated.

Additional magnesia would be furnished these waters by the various augitic rocks, among which the traps are included; also by dolomites.*

The action of heated waters is often indicated in the regions of these pseudomorphs, by the rounded angles or pitted surfaces of otherwise unaltered crystals.

Other evidence that heated water has been the agent, is found in the frequent change of quartz to steatite. Hot magnesian waters alone could have effected the slow solution of the silica, and the introduction of magnesia, that constitute the change here indicated. Hot vapours, it is true, would equally dissolve silica, but they would not afford the necessary magnesia; and, moreover, exposure to such vapours would have destroyed the form of the crystal.

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* The interesting analyses of B. Silliman junior, have shewn that the ocean's waters, through animal agency (the growth of corals), have afforded a great part of the magnesia that is contained in dolomites.

This view is further corroborated by the occurrence of *siliceous* pseudomorphs along with those of steatite. The steatitic spinels, also, of the same localities, afford other proof, as the change in these crystals has consisted in a substratum of silica for alumina—thus making a *silicate of magnesia* out of what was before an *aluminate of magnesia*—a change that requires water and heat for the solution of the silica, and heat no less for effecting the transfer of elements.

The fact that the majority of these pseudomorphs contain water, is other proof that the heat producing the change was not a dry heat, but was diffused through water. Dr Blum does not seem to recognise the fact of the hydrous character of the steatitic pseudomorphs in his work; yet analyses have shewn, that, in very many instances, the steatite is a hydrous mineral, and not true steatite. Serpentine and chlorite, also, contain a large per-centage of water.*

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* The agency of hot waters and vapours in producing changes in rocks, though recognised by many geologists, does not seem to have received sufficient attention. When we consider the number of hot springs on the surface of the earth, in regions of modern volcanic action, and in others not of this nature—when we remember the many eruptions of hot water, even from subaerial volcanoes—and when, further, we have before our eyes the wide-spread effect of volcanic action beneath the sea, can we refuse to the agency of heat, thus conveyed by vapours and flowing waters, a *large part*, at least, of the various metamorphic changes manifest on the surface of the earth, especially if we take into view the condition of a vast volcanic region in full submarine action, its floods of melted rocks, its opened fissures, for a long period in action, its fountains of boiling waters and rising vapours? The whole surface of the earth evinces that this submarine action, under an ocean's pressure, has been almost co-extensive with it. The vast number of dikes that traverse the rocks suggest the same fact. Where are the effects of this heat, if not in these pseudomorphic and metamorphic changes? Professor Keilhau attempts to account for the crystallization of the dolomites, by the hypothesis of slow molecular changes taking place at the ordinary temperature. But why refuse the aid here proffered? The fact that one part of a sedimentary limestone is crystallized, while another is not, is fully explained by this view; while his theory serves only to increase

Calc-Spar to Bitter-Spar.—This change comes under the same head with those first explained. A change of this kind does not require a complete solution of the lime; for late investigations have shewn that molecular attractions take place at higher temperatures, without solution of all the elements concerned in the change.

Carbonate of Lead to Minium.—Minium is easily produced from carbonate of lead by means of heat.

Andalusite, Wernerite, and Tourmaline to Mica.—These changes must have required the high temperature that crystallized the mica in the metamorphic rocks.

Augite to Opal.—Dr Blum suggests that this change is probably effected by means of the sulphur vapours of the volcano decomposing the volcanic rock. The writer has seen siliceous incrustations produced in this way at the sulphur beds of Kilauea, Sandwich Islands, where the basaltic lavas are gradually crumbling down through this action, to a yellow earth. The sulphuric acid removing the lime of the augite forms sulphate of lime, which is found in snowy fibrous seams and incrustations.

We do not attempt to offer explanations of all the several instances of pseudomorphs. A more particular examination of the various localities, the associate minerals, and their situations in the rocks, is necessary before this can be done.

The principal obstacle in the way of chemically investigating and imitating these processes in nature, lies in these two facts: *First*, That it is difficult, by laboratory experiments, to appreciate the effect of agents acting slowly for a long period of time, under circumstances of temperature and electric forces beyond our cognizance; *Second*, we cannot know fully the exact conditions and composition of waters intensely heated under pressure, and rendered by this means capable of dissolving many refractory minerals.

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the mystery that hangs around this subject. The fact, also, that these crystallizations have taken place without evidence of the intense heat necessary for fusion, is fully explained; for, as Keilhau states, crystallization has been lately shewn by many facts to take place without fusion, or even softening, yet not, as this author would urge, without some increase of temperature.

In the preceding remarks, it has been our object simply to discuss the principal agencies that must have been in operation, in order to prepare the way for a more complete elucidation of the subject, by future developments.

The importance of these discussions to geology is not to be measured by the length of the catalogue of pseudomorphs. The same process that has altered a few crystals to quartz, has distributed silex to fossils without number, scattered through rocks of all ages. The same causes that have originated the steatitic scapolites occasionally picked out of the rocks, have given magnesia to whole rock formations, and altered throughout their physical and chemical characters. If it be true that the crystals of serpentine are pseudomorphous crystals, altered from chrysolite, it is true also, as Breithaupt has suggested, that the beds of serpentine containing them, are likewise altered, although often covering square leagues in extent, and common in most primary regions. The beds of steatite, the still more extensive talcose formations, contain every where evidence of the same agents. The deposits of the so-called Rensselaerite, in northern New York, are other examples of the widely extended influence of the pseudomorphic agencies.—*American Journal of Science and Arts*, vol. xlviii., No. 1, p. 81.

A new Self-Acting Method of Taking the Buckets from the Pit Mouth, and Shutting off the Steam from the Winding Engine. By Mr Daniel Erskine, F.R.S.S.A., (with a Plate). Communicated by the Royal Scottish Society of Arts.*

The object of this improvement is, to prevent the ropes of coal-pit engines from being over-wound, and to prevent the many accidents that occur by the buckets being carried over the pulleys. To effect this, the bucket is taken off the pit mouth and placed upon a platform, and the steam is shut off from the engine without the assistance of the engineer. The full bucket is then let down an inclined plane, the weight of

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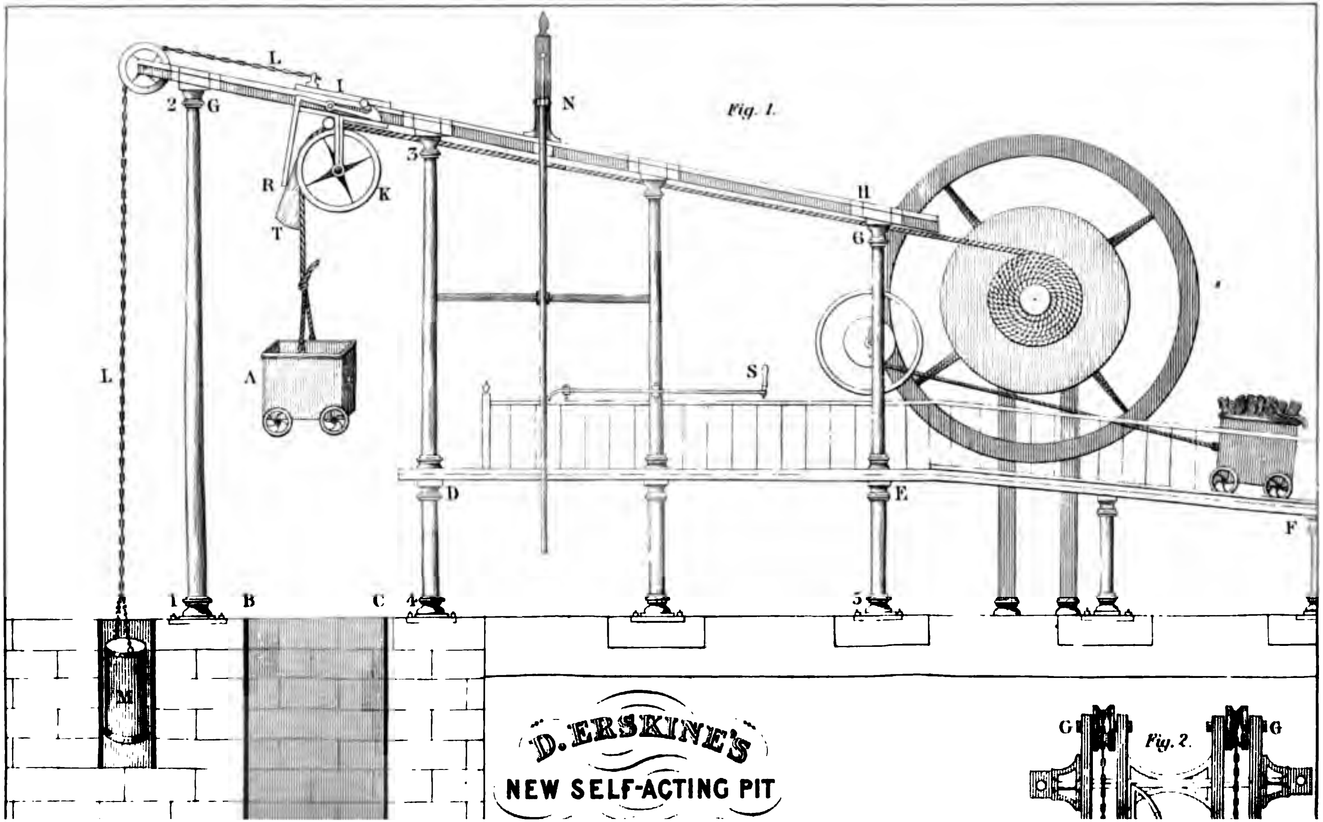
* Read, and model exhibited to the Society, on 14th April 1845.



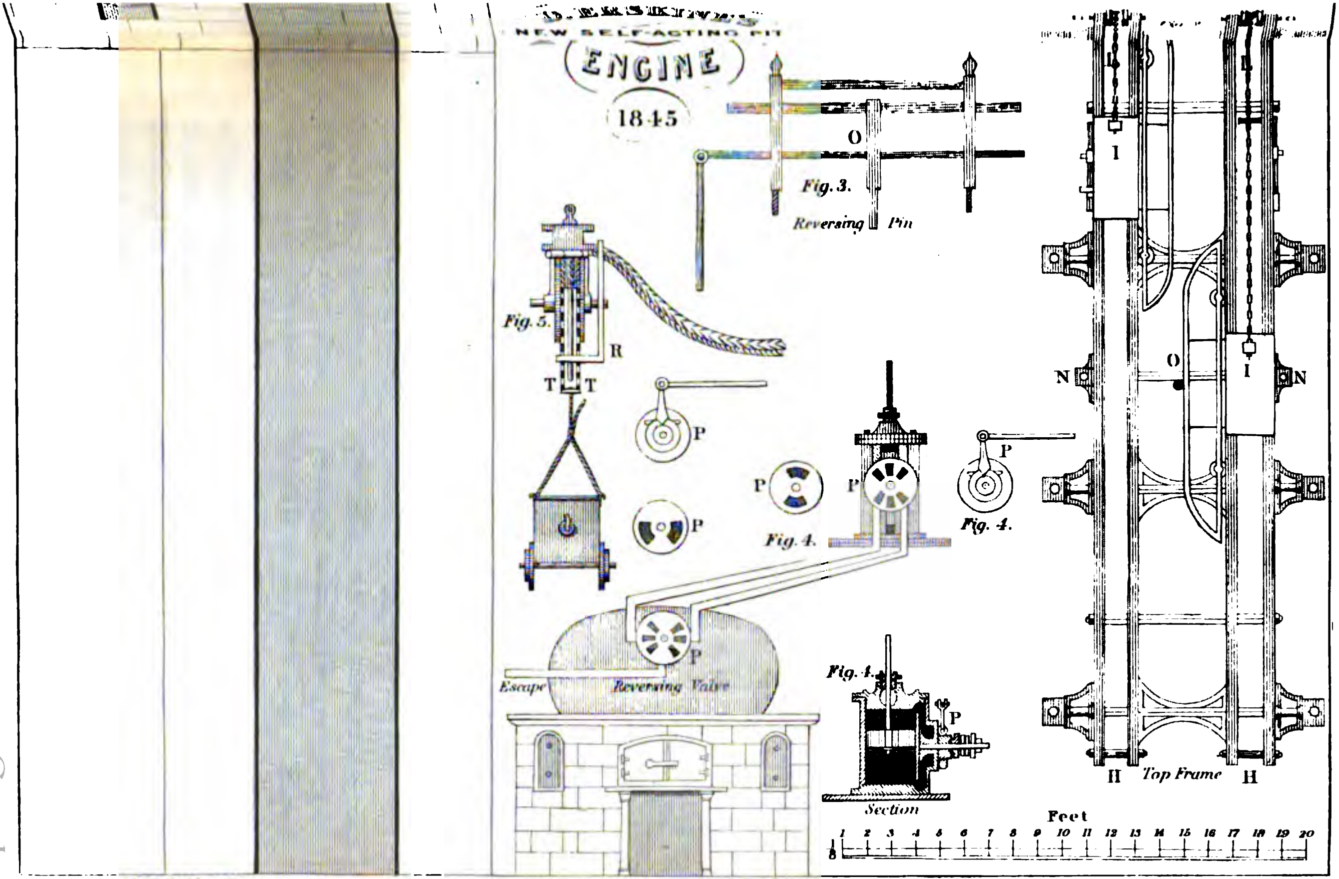
D. ERSKINE'S NEW SELF-ACTING PIT

D. ERSKINE'S

NEW SELF-ACTING PIT

ENGINE

1845



Invented & Drawn by D. Erskine, Alloa.

S. Leith's Lithog.

the full bucket bringing up the empty one to the engineer's hand. The work is thus done much better and cheaper, as it could be done with fewer men, and without the danger that often occurs by careless men neglecting their duty. The new method may shortly be described thus: (See Plate III.)—At the pit mouth B C (fig. 1), a platform D is fitted about six feet from the pit mouth, and extends to E, about 30 feet back from the pit,—the width of the platform being from 10 to 12 feet; and at the farthest end of the platform there is an inclined plane E F attached, down which the full bucket runs, the weight of which brings up the empty bucket to the engineer's hand. At the pit mouth are fixed four upright posts or pillars, 1, 2, 3, 4, about 14 feet in height above the platform. On the top of these are fitted two double rails or shears, G H, G H (figs. 1 and 2), which are sloped down from 14 to 10 feet at 5, 6 (fig. 1), and are extended about 20 feet back. In the centre of each double rail is fitted a block I I (figs. 1 and 2), which has freedom to slide up and down the rails; and in each block is a pulley K, which is suspended downwards for the ropes of the buckets to pass over. To each block is fitted a chain L L (figs. 1 and 2), which is extended over the pit mouth, and to which is suspended a round box M, of sufficient weight to carry out the empty bucket to the pit mouth. On the top of the shears is fixed a frame N N (figs. 2 and 3), with a pin O (figs. 2 and 3), to move right and left, which is connected with my pivot-valve P P (fig. 4), which makes the best reversing-box. Thus, when the pin is moved to the centre betwixt the shears, the steam should have communication to top and bottom of the cylinder at the same time; but the valve of the model being so very small, I was afraid to make the ports larger, in case the surface betwixt the ports should have been rendered too small; but, by the way in which the valve is fitted, it shuts off the steam from the cylinder, which will be sufficient to shew the principle. When the engine is in motion, the bucket is lifted up to the pit mouth; the rod of the bucket T opens the lever R, brings in the bucket, and places it upon the platform D E, and then shuts off the steam from the engine by touching the pin O; and all that the engineer will have to do is to unhook the full bucket, and set it down the railway E F, and to hook on the empty bucket which is brought to his hand, and then set on the engine by the handle S, and in return the engine will do its work.

DANIEL ERSKINE.

18*th March* 1845.

The Committee appointed to examine Mr Erskine's apparatus, report favourably of its efficiency.

On the Rock-Nose of the Whaler, a variety of the Balæna Mysticetus. By ALEXANDER H. GUERIN of Geneva, Surgeon of the Ship Superiéur. Communicated by the Author.*

It seems somewhat remarkable that an animal, apparently so very different, in many points, from the common whale, as to have deserved from the whaler a distinct name, should have escaped the notice of the many intelligent and active naturalists who have visited the Arctic Regions. We do not find it mentioned anywhere; and although Scoresby, the highest authority on the subject, tells us that the Mysticetus is met with in the bays and inlets of Davis' Straits, and that there are some differences observed in different animals which might be considered as constituting them varieties, he gives no notice of any difference in their habits (Arc. Reg. v. i., p. 469). It does not appear that any other writer had even a suspicion of the Rock-nose, as it is called, being a variety.

The true Mysticetus is often found in the Straits, though not generally near the coast, but at a distance from the land ice, and among the heavy floating ice, known as the *middle ice*. It is not till towards the latter part of the fishing season that this whale is seen along the shore, which it then approaches on its way to the south; though some years it goes south along the edge of the middle ice, without coming near the land. The Rock-nose, on the contrary, never leaves the coast, and though often, when crossing a bay, it goes from point to point or cape to cape, it as often takes a more circuitous route, and follows the shore, the whole way round the inside of the bay. In its passage south, the last mentioned whale goes either in shoals, single, or, as I have seen occasionally, in pairs, when the two seem to act in concert, coming to the surface of the water and sinking at the same instant.

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* Mr Guerin visited Greenland in the year 1844.

There is a strange peculiarity in the habits of the Rock-nose, from which it has received its rather curious, though very expressive and appropriate name. It frequently places the extremity of its head, or nose as the whalers call it, close to the shore, upon a rock, or on the steep and stony bottom, with its spiracles, and part of its head and body above the surface of the water, and there remains perfectly motionless for several minutes. I have seen several of them in that position; and on one occasion, a pair of them, within a few feet of each other, remained as just described, for more than ten minutes. Though they were within a hundred yards of the ship, the breathing was so slow and easy, as neither to be perceived nor heard. All our boats, except the stern boat, were away; this last was immediately lowered, brought alongside, manned, and sent in chase; but still, after all these preparations, which took a long time, it was not till the harpooner stood up, with harpoon in hand, ready to strike, that the whales began to move; which they did so swiftly as to be out of sight in an instant, and were not seen again. This happened at the beginning of our long stay in Cape Searl Sound. It is the opinion of the whalers that when in this position, the Rock-nose is feeding. This, however, I can scarcely believe, as I never perceived the slightest motion of the jaws or the head of the animal; on the contrary, the whole frame, as far as could be judged by the parts above water, was perfectly motionless. I therefore think it more probable that the Rock-nose is then resting itself, being enabled by its position, to breathe more at ease, with less effort, and, consequently, be the more ready to renew its exertions either to feed or proceed farther to the south.

I have also to remark that the period of the emigration of the Rock-nose seems somewhat different from that of the true Mysticetus; the last-mentioned, setting out on its way south during the first fortnight of September; whilst the former does not generally appear in the lat. 66° to 69°, in any considerable numbers, till the last fortnight of the same month, and often is seen there, as late as the 8th or 10th of October. The state of the ice and weather, and the age of the individual, have, as is generally believed, considerable influence over the period of emigration of whales in general.

Having described the habits of these animals, which remain in large shoals in the bays and inlets of lat. 71° to 74°, I shall now proceed to shew that there is also a considerable difference in shape between the Rock-nose and the true Mysticetus.

In pursuing this inquiry I experienced considerable difficulty. It is of such importance to have the whale flenched immediately after it has been towed alongside, that it is almost impossible to allow time for actual measurement; besides, the men are generally tired, and require rest and refreshment, so that none could be found to assist in measuring, an operation which no one could possibly carry on by himself. I shall, therefore, mention the differences which struck my eye, and which, upon inquiry, I found to be the general characters by which the Rock-nose is distinguished by the whaler.

The most important point is the comparative size of the head and body. A Rock-nose of 10 feet whalebone, is, taking the extreme length of the animal, from 8 to 10 feet shorter than a true Mysticetus having the same length of whalebone, as it seldom reaches above 40 or 42 feet. Of this extreme length the head is always considerably more than a third; whilst, in the true Mysticetus, it is, as stated by Scoresby, as 16 to 51, consequently less than the third.

The whalebone is longer in comparison to the length of the animal, but the laminæ are thin for their length.

The body is broader and terminates more abruptly.

The tail seems equal in length and breadth to that of the true Mysticetus of the same size.

The colour of the skin is a dark velvet brown, and has fewer white spots than that of the other species or variety.

The Rock-nose yields less oil, compared to the length of whalebone, than the true Mysticetus.

The above comparison of the two animals induces me to believe them distinct from each other; although the whalers in general seem to think that it is merely a difference of age that causes this difference in their external characters. This, however, appears to me very improbable. If we take a glance at zoology in general, we find that animals of about the same age are about the same size, when under similar circumstances. I would, therefore, be inclined to believe that two whales of the same species, of the same length of whalebone, would be of about the same age, and would present nearly the same external characters; but when we find a constant and considerable difference both in habits and form, we may, with reason, infer that the two individuals are marked varieties at least, if not different species. Besides, we generally find, among animals, that those that are fit for reproduction, or have already given birth to one or two individuals, have attained the regular proportions and the instincts belonging to that particular species. Now, as cubs or suckers are as often found among the Rock-noses as among the Middle ice whale, the former must have attained the age of maturity; as we cannot suppose that the Greenland whale can be an exception to the general rule. I cannot believe, therefore, that a number of these animals, after they have arrived at maturity, should still retain a difference in shape and habits, confining themselves to the bays and inlets; whilst the other portion, at the same period of life, changing its instinct and shape, leaves the shore and goes to roam at 30 or 40 leagues from the coast, and that under the same latitude, the same climate, and under similar external circumstances. I therefore conclude that the Rock-nose is a distinct variety, if not a distinct species. There is no doubt that the Middle ice whale is the true Balæna Mysticetus; but whether or not the Rock-nose is the same species as the Mysticetus of the *South Sea*, is a question I am not able to decide.

On the Registry of the Hourly Variations of the Thermometer, by means of Photographic Papers. By MUNGO PONTON, Esq., F.R.S.E., F.R.S.S.A. Communicated by the Royal Scottish Society of Arts.*

An unexceptionable mode of registering the hourly variations of the common mercurial thermometer, has long been a desideratum in science. Hitherto we have been able to register only the maximum and minimum of temperature for each day and night, and even that in rather an imperfect manner; but to record the hourly movements of the mercury in the thermometer has not, so far as I am aware, been as yet successfully attempted. Various purely mechanical methods have been tried from time to time, but without satisfactory results. Nature, however, is full of appliances; and it only requires perseverance on our part to avail ourselves of the implements so profusely scattered around us.

The newly discovered phenomena of photography appeared to me likely to afford facilities for attaining the object in view; and the results I have arrived at lead me to hope, that we may successfully employ light to record, with its subtile pencil, the changes in the heat of the atmosphere.

The first difficulty to be overcome was to obtain a clear and well defined shadow of the filled portion of the bore of the thermometer, capable of being distinguished from the shadow produced by the empty portion. This is a matter of some nicety. After several trials, the following appeared to be the best mode of securing this result:—Select a thermometer with a flat bore, and grind the stem down on one side nearly to the bore, so as to produce a flat, or rather slightly concave, polished surface, and let the opposite side be ground only a little flat. If the latter flattened side be now exposed to the light of a lamp or gas flame, condensed by means of a cylindrical glass vessel filled with water, placed at a considerable angle, it will be found, that by a little nice adjustment a certain position will be obtained, in which the shadow of the bore may be thrown on a piece of paper placed against the other ground surface of the stem, in such a manner that the shadow of the empty part of the bore is reduced almost to nothing, while that of the filled portion is considerably expanded, and well defined. A little practice suffices to hit the best adjustment.

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* Read before the Society on 10th March and 12th May 1845.

The next point was to obtain a photographic paper sufficiently sensitive to be affected by artificial light at a convenient distance, and in a sufficiently short time, but which could at the same time be kept long enough without injury. After various unsuccessful attempts, I have ascertained that paper prepared in the manner to be described, answers the purpose perfectly. The process is a modification of that discovered by Hunt, and to which he has given the name of Energiatype.

The paper is first to be coated with either the iodide or the chloride of silver;—I prefer the latter. The usual mode of washing, first with the nitrate of silver, and then with either the iodide of potassium, or the chloride of sodium, may be adopted for this purpose. It is desirable to have a good coating of either the iodide or chloride of silver on the paper. The soluble salt having been well washed out, by immersing the paper in clean cold water, it is next to have applied to it a saturated solution of succinic acid. In this state the paper may be preserved for any length of time, if kept dry, and carefully excluded from light.

Before use, a wash of the aceto-nitrate of silver, as directed to be prepared by Talbot, is to be applied. This gives the paper the necessary degree of sensitiveness, and in this state it may be kept without injury to its properties for two or three days, but not more.

If the aceto-nitrate be applied without the previous wash of succinic acid, the paper will be equally sensitive; but it will blacken spontaneously in the dark, and is therefore useless for the purpose. The succinic acid thus appears to exert a conservative influence in preventing spontaneous decomposition.

The photographic image formed on this paper is latent, and requires to be brought out by the application of a saturated solution of the sulphate of iron, mixed with three or four times its bulk of mucilage of gum-arabic. This mixture should be freshly prepared, for it soon becomes a jelly, which is unfit for use. The application of the sulphate of iron to the paper may be made at the distance of upwards of 24 hours from the time of the first impression of the latent image, which will, notwithstanding that lapse of time, come out distinctly; and thus a whole day's record may be brought out at once. The aid of a little heat is sometimes necessary for the development of the image.

The mechanical arrangements are these:—A black japanned cylinder of tin, about 4 inches diameter, and 4½ inches deep, has a piece of the sensitive paper wrapped round it. This cylinder is intended to be moved round by a time-piece, and to traverse behind the stem of the thermometer. It will be stationary for a half or a quarter of an hour as desired, at each division of the cylinder, and then be moved a division by a jerk. There will thus be time for the image to be completely formed by the action of the light. Around the cylinder carrying the sensitive paper is another blackened cylinder, 4¼ inches diameter and 4 inches deep, with a slit in it just sufficient to admit the stem of the thermometer. This is intended to screen from the light all that portion of the paper which is not in action. A cover goes over the whole, the more effectually to exclude all light except that which passes through the stem of the thermometer. The stem itself is also furnished with wings of black paper, to prevent the light from spreading on either side.

The thermometer should have its stem twice the length of what is required for the natural range of temperature, so that the bulb may be placed at a considerable distance from the portion acted on by the light, in case of any increase of temperature from that cause; and the bulb and lower portion of the stem should be completely screened from the light. This is accomplished by placing the thermometer in a wooden box, the bulb and the lower half of the stem being in the box, which is open behind to admit the air, while the upper portion of the stem, intended for use, is left standing above the box. The time-piece may be placed in this box if convenient.

The cylinders already described, are placed behind the exposed portion of the stem, so that the image of the bore may be received on the sensitive paper surrounding the inner cylinder, care being taken that the paper be applied as closely as possible to the stem.

The whole apparatus is now to be placed near a lamp, or a good sized gas flame, the light from which is to be concentrated on the stem by means of a cylindrical glass bottle filled with water, as already described. If the registration is to be half-hourly, the distance of the light may be about 2 feet; if every quarter of an hour, the distance should be about 1 foot.

By this arrangement the image of the mercury in the bore, as it stood during each half or quarter of an hour, is impressed on the paper in a latent state, and the whole series may be brought out at once by the sulphate of iron at the end of the 24 hours.

A scale is to be adapted to the cylinder to determine the degrees, and corresponding marks should be made on the paper, so that the scale may be applied to it after removal from the cylinder. A slip of paper about an inch and a half broad, placed on that portion of the cylinder where the mercury may be expected to range, will, in general, be found sufficient.

The same method of registration, although peculiarly applicable to the thermometer, may be also employed for the registration of the barometer and other instruments. It has this peculiar advantage, that it does not interfere in the smallest degree with the natural action of the instrument, but merely takes a picture of the state of the instrument during a given time. The chief expense would be that of the artificial light, but this might be partly economised, by a contrivance for that purpose. The same artificial light might also be used for registering several instruments.

The photographic paper which I have found best adapted for the above purpose, is equally fitted for taking landscapes in the camera obscura, because it keeps well for being taken to the field, and may also be allowed to remain for so considerable a time before the image is brought out.

Additional Communication.[*]

Since my former communication to the Society on this subject, Mr Bryson has had the kindness to adapt to the photographic thermometer a clock movement, so as to complete the arrangements necessary for a half-hourly registration of the temperature. The connexion is formed by means of a spindle, terminating in a small pinion, and attached to the striking train of the clock. The pinion works into a horizontal toothed wheel, carrying the cylinder, on which is placed the sensitive paper, and which is thus, by the action of the clock, moved one division every half hour.

Farther experiment having proved, that, by a more perfect concentration of the light, a sufficient effect could be produced on the paper by an exposure of four or five minutes, it appeared advantageous to limit the exposure to this extent, by providing for the raising and lowering of the gas flame, so that it might be raised to its full pitch for about five minutes every half hour, and continue burning with a very small flame during the rest of the time.

In order to obtain a better concentration of the light, I employ a lenticular piece of glass, 4½ inches in length, 3 in width, and about ½ inch thick in the middle. This produces a long narrow light along the stem of the thermometer. I find it advantageous, in using a fish-tail burner, to turn the edge, instead of the flat side of the flame, towards the lens.

For the purpose of raising and lowering the gas, the clock is furnished with two hands, forming a diameter of the circle. Over or under the centre on which these hands turn, is placed a perpendicular lever, terminating at bottom in a small roller. Proceeding from one end of the lever is a thread passing over a pulley at a little distance, and having a small weight suspended to it, by which the lever is pulled a little aside from the perpendicular position.

In the gas tube a knee is formed, and immediately over the place where the gas passes from the perpendicular into the horizontal tube, there is a small rectangular chamber; and the termination of the perpendicular pipe is a flat rectangular piece of brass at the bottom of the chamber, having a hole in its centre for the admission of the gas. On this flat surface rests a small rectangular piece of iron, reaching to about $\frac{1}{16}$th or $\frac{1}{20}$th of an inch from the top of the chamber which is closed. Above the flat top of the chamber is suspended, on an axis, a small horse-shoe magnet, with a lever several inches long projected from its upper curvature. To the end of this lever is attached a thread, which proceeds to the upper limb of the lever above the clock. By this attachment the magnet is drawn aside from the chamber in the gas tube, and, consequently, the piece of iron in that chamber being unaffected by the magnet, rests over the orifice for the admission of the gas, which it closes to such an extent as to admit only a minute portion, sufficient to keep up a very small flame.

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[*] Read before the Society, 12th May 1845.

When the hands of the clock approach the perpendicular position, the upper hand presses against the roller at the bottom of the lever; and, as the hand moves round, it carries the lever with it, and thus raises the small weight above mentioned, at the same time slackening the thread attached to the magnet, which being thus at freedom to move, is attracted towards the iron in the chamber. So soon as the poles of the magnet reach the top of the chamber the piece of iron jumps up towards them, and thus lets on the full flow of the gas, raising the flame to its highest pitch at once. This state of matters remains while the hand of the clock moves onwards for about five minutes, carrying the lever with it, and so continuing to raise the small weight. At the expiration of the five minutes the hand of the clock passes the lever, which instantly returns to its original position, and, in consequence of the accumulation of power attending the fall of the weight from the height to which it has been raised, the lever returns with such force as to jerk the magnet away from the chamber in the gas pipe, and thus allow the piece of iron in that chamber to drop into its original position, and thereby reduce the gas flame at once to its lowest point.

By these means the raising and lowering of the gas is accomplished with less strain upon the clock than it would be were a stop-cock employed.

In order to prevent the action of extraneous light during the day, it has been found advisable to place between the lens and the thermometer a small screen, which is opened and shut by the action of the same lever that raises and lowers the gas. The thermometer is thus exposed only while the gas flame is at its height.

For the successful production of the images of the mercurial column in the thermometer tube, every thing depends on the light being made to fall upon it at the proper angle, so as to obliterate the shadow from the empty part of the bore, and increase the shadow produced by the full portion. Unless this position be hit the images will not be distinct.

As it appeared desirable to have it in our power so to arrange matters that the clock might be inside of the house, while the thermometer and registering cylinder stand outside, I have contrived a method by which this may be accomplished. It is on the same principle as that by which the gas is raised and lowered, and may be managed by the same lever, so that the shifting of the cylinder takes place at the same instant that the gas is lowered, just after the registration has been completed. The only connection between the clock and the cylinder is a thread, which may pass through the window. I have had this plan in action, but the apparatus requires some little alteration.

By this arrangement it is easy to cause the same clock register both a thermometer and a barometer, or even a barometer and two thermometers, one placed in the sun, the other in the shade; while the registration of the barometer may be either by the photographic method, or by the mode previously invented by Mr Bryson.

The Committee appointed to examine Mr Ponton's Photographic Thermometer, report very favourably.

Carbonic Acid and Sulphureous Acid Springs—Cold Springs—Hot Springs—Mud Volcanoes—Volcanoes. By Baron ALEXANDER VON HUMBOLDT.*

Having now taken a general survey of the activity, that is, of the internal life of the globe, in its heat, in its electro-magnetic tension, in its luminous emanations at the poles, in its irregularly-recurring phenomenon of motion, we come to chemical changes in the crust of the earth, and in the composition of the atmosphere, which are, in like manner, the consequence of planetary vital activity. From the ground we see effusions of watery vapour and of gaseous carbonic acid, mostly free from all admixture of azote; of carburetted hydrogen gas, in the Chinese province of Sse-tschuan, for thousands of years, and in the state of New York, where, in the village of Fredonia, it has lately been employed for economical purposes in heating and lighting;† of sulphuretted hydrogen gas, of sul-

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* This extract from Cosmos (English edition by Bailliere) at present in course of publication, is slightly altered and enlarged.

† *Carburetted Hydrogen Spring at Fredonia.*—Sailed in a steam-boat to Fredonia, a town of 1200 inhabitants, with neat white houses, and six churches. The streets are lighted up with *natural gas*, which bubbles out of the ground, and is received into a gasometer, which I visited. This gas consists of *carburetted hydrogen*, and issues from a black bituminous slate, one of the beds of the Hamilton group of the New York geologists, or part of the Devonian formation of Europe. The lighthouse-keeper at Fredonia told me, that, near the shore, at a considerable distance from the gasometer, he bored a hole through this black slate, and the gas soon collected in sufficient quantity to explode, when ignited.—*Travels in North America.* By Charles Lyell. Vol. ii., p. 89.

Burning Spring of Niagara.—At the Falls of Niagara, where we next spent a week, residing in a hotel on the Canada side, I resumed my geological explorations of last summer. Every part of the scenery, from Grand Island above the Falls, to the ferry at Queenstown, seven miles below, deserves to be studied at leisure.

We visited the "burning spring" at the edge of the river above the rapids, where carburetted hydrogen, or, in the modern chemical phraseology, a light hydro-carbon, similar to that before mentioned at Fredonia, rises from beneath the water out of the limestone rock. The bituminous matter supplying this gas is probably of animal origin, as this limestone is full of marine mollusca, crustacea, and corals, without phur fumes, and, more rarely, of sulphureous and hydro-chloric acid vapours. Such emanations from fissures in the ground, do not only indicate the dominion of volcanoes long extinct or still burning; they are farther observed exceptionally in districts in which neither trachyte nor any other volcanic rock appears at the surface. In the Andes of Quindiu, I have seen sulphur precipitated from hot sulphureous vapours issuing out of mica-slate, at a height of 6410 feet above the level of the sea; whilst the same, and, as it used to be regarded, primitive rock, in Cerra Cuelo, near Ticsan, south of Quito, exhibits an enormous bed of sulphur in pure quartz.

Of all the gaseous springs which the earth pours forth, those of carbonic acid (mofetten) are still, at the present time, the most important, both in number and extent. Germany, in her deeply-cut valleys of the Eifel, in the neighbourhood of Lake Lach, in the Kesselthal of Wehr, and in Western Bohemia, as also in the burning foci of the primeval world, or their vicinity, shews us these effusions of carbonic acid as a kind of last effort of volcanic activity. In former epochs, where, with a higher temperature of the earth, and the frequency of fissures yet unfilled, the processes which we are here describing proceeded more actively where carbonic acid gas and watery vapours were mingled with the atmosphere in larger quantities than at present, the youthful vegetable world, as Adolph Brongniart has acutely observed, must have attained almost everywhere, and independently of geographical position, to the most rank luxuriance and evolution of its organs. In the ever hot, ever moist atmosphere, surcharged with carbonic acid, vegetables must have found such vital excitement, such superfluity of nourishment, as enabled them to supply the material of those beds of coal and lignite, the exhaustion of

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vegetable remains, unless some fucoids may have decomposed in the same strata. The invisible gas makes its way in countless bubbles through the clear transparent waters of the Niagara. On the application of a lighted candle, it takes fire, and plays about with a lambent flickering flame, which seldom touches the water, the gas being, at first, too pure to be inflammable, and only obtaining sufficient oxygen after mingling with the atmosphere at the height of several inches above the surface of the stream.—*Lyell's Travels in North America*, vol. ii., p. 90.—*Edit. of Phil. Journal.*

which it is difficult to conceive, and which now serve as foundations for the physical strength and the welfare of nations.* Such beds are principally contained in basins, and are peculiar

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* In Lyell's interesting Travels in North America, already quoted, we meet with the following remarks on the quantity of carbonic acid in the atmosphere, in which the plants of the coal formation flourished:—" Before concluding the remarks, which are naturally suggested by a visit to the Great Dismal, I shall say a few words on a popular doctrine, favoured by some geologists, respecting an atmosphere highly charged with carbonic acid, in which the coal plants are supposed to have flourished. Some imagine the air to have been so full of choke damp during the ancient era alluded to, that it was unfitted for the respiration of warm-blooded quadrupeds and birds, or even reptiles, which require a more rapid oxygenation of their blood than creatures lower in the scale of organization, such as have alone been met with hitherto in the carboniferous and older strata. It is assumed, that an excess of oxygen was set free when the plants which elaborated the coal subtracted many hundred million tons of carbon from the carbonic acid gas which previously loaded the air. All this carbon was then permanently locked up in the solid seams of coal, and the chemical composition of the earth's atmosphere essentially altered.

But they who reason thus are bound to inform us what may have been the duration of the period in the course of which so much carbon was secreted by the powers of vegetable life; and, secondly, what accession of fresh carbonic acid did the air receive in the same. We know that, in the present state of the globe, the air is continually supplied with carbonic acid from several sources, of which the three principal are, *first*, The daily putrefaction of dead animal and vegetable substances; *secondly*, The disintegration of rocks charged with carbonic acid and organic matter; and, *thirdly*, The copious evolution of this gas from mineral springs and the earth, especially in volcanic countries. By that law, which causes two gases of different specific gravity, when brought into contact, to become uniformly diffused and mutually absorbed through the whole space which they occupy, the heavy carbonic acid finds its way upwards through all parts of the atmosphere, and the solid materials of large forests are given out from the earth in an invisible form, or in bubbles rising through the water of springs. Peat mosses of no slight depth, and covering thousands of square miles, are thus fed with their mineral constituents, without materially deranging the constituents of the atmosphere breathed by man. Thousands of trees grow up, float down to the delta of the Mississippi and other rivers, and are buried, and yet the air, at the end of many centuries, may be as much impregnated with carbonic acid as before.

Coral reefs are, year after year, growing in the ocean; springs and to certain parts of Europe. They are abundant in the British Isles, in Belgium, in France, on the Lower Rhine, and in Upper Silesia. In the same primeval times of all-pervading volcanic action, too, must those enormous quantities of carbonaceous matter have issued from the bowels of the earth, which all the limestone rocks contain, and which, separated from oxygen, and represented in the solid form, composes about an eighth part of the absolute bulk of those mountain masses. The carbonic acid which the atmosphere still contained, and which was not absorbed by the alkaline earths, was gradually consumed by the vegetation of the primeval world; so that the atmosphere, purified by the processes of vegetable life, by and by contained no more of the gas than was uninjurious to the organization of such animals as people the earth at the present time. Sulphurous or sulphuric acid vapours, too, occurring more frequently, and much more abundantly, then than now, occasioned the destruction of the inhabitants of the inland waters—mollusca and numerous genera of fishes, as well as the formation of the strangely contorted beds of gypsum, which have often, apparently, been shaken by earthquakes.

Under precisely similar physical relations, there were further thrown out from the bosom of the earth various gases and liquids, mud, and, from the eruption cones of volcanoes, which are but a species of intermitting springs, streams of

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rivers feed the same ocean with carbonic acid and lime; but we have no reason to infer, that when mountain masses of calcareous rock have thus been gradually formed in the sea, any essential change in the chemical composition of its waters has been brought about. We have no accurate data, as yet, for measuring, whether in our own time, or at any remote geological era, the relative supply and consumption of carbon in the air or the ocean, causes the amount of those elements to vary greatly; but the variation, if admitted, would not have caused an excess, but rather a deficit, of carbon, in the periods most productive of coal or peat, as compared to any subsequent or antecedent epochs. In fact, a climate favouring the rank and luxurious growth of plants, and, at the same time, checking their decay, and giving rise to peat or accumulations of vegetable matter, might, for the time, diminish the average amount of carbonic acid in the atmosphere—a state of things precisely the reverse of that assumed by those to whose views I am now objecting.—*Travels in North America.* By Charles Lyell. Vol. i., p. 150.—*Edit. of Phil. Journal.*

molten earths. All these matters owe their temperature, and the nature of their chemical constitution, to the place of their origin. The mean temperature of ordinary springs is lower than that of the atmosphere where they appear, when the water is derived from high levels; their temperature increases with the depth of the strata with which they come in contact at their origin. The numerical law of this increase has been stated above. The mixture of the waters, which come from the mountain elevations, or from the depths of the earth, renders the position of the isogeothermal lines, or lines of equal internal heat of the earth, difficult of determination, when the conclusion has to be come to from the temperature of springs as they rise. So, at least, did I and my friends find it in some experiments which we made in Northern Asia. The temperature of springs, which has been so constant an object of physical investigation for the last half century, depends, like the height of the line of perpetual snow, on numerous and highly complex causes. It is a function of the temperature of the stratum in which they have their origin, of the capacity for heat of the ground, and of the quantity and temperature of the atmospheric or meteoric water that falls; which last, again, according to the mode of its origin, differs in its temperature from that of the lower strata of the atmosphere.

Cold springs, as they are called, can only give the mean temperature of the air, if unmixed with water that is rising from great depths, or that is descending from considerable heights, and when they have flowed for a very long way under the surface—in our latitudes from 40 to 60 feet, in the equinoctial zone, according to Boussingault, one foot. These depths are those, in fact, of the stratum of rock in which, in the temperate and torrid zone respectively, the point of invariable temperature begins, in which the hourly, diurnal, or monthly variations in temperature of the air are no longer perceived.

Hot springs burst out of the most diversified mineral strata; the hottest of all the permanent springs which have yet been observed, and which I myself discovered, flow remote from all volcanoes. I here refer to the Aguas calientes de Las Trincheras between Porto Cabello and New Valencia, in South America, and to the Aguas de Comangillas, near Guanaxuato, in Mexico. The first spring, issuing from granite, indicated 90·3° C.; the second, which issues from basalt, shewed 96·4° C. The depth of the source of water of these temperatures, from what we know of the law of increase of temperature in the interior of the earth, must probably be about 6700 feet (more than half a geographical mile). If the cause of the heat of thermal springs, as well as of active volcanoes, be the universally diffused heat of the earth, then would rocks produce an effect only through their capacity for, and their power of, conducting heat. The hottest of all the permanent springs, those, namely, from 95° to 97° C. (204° to 207·6° F.), it is remarkable, are the purest, are those that contain the smallest quantity of mineral matter in solution. Their temperature appears, on the whole, to be less permanent than that of springs between 50° and 74° C., the invariableness of which, both in regard to temperature and mineral impregnation, has been maintained so wonderfully, within the confines of Europe at least, during the last fifty or sixty years, *i. e*., since accurate thermometrical observations and chemical analyses were made. Boussingault found that the thermal springs of Las Trincheras had risen in temperature, in the course of twenty-three years (from 1800, when my journey was performed, to 1823), from 93·3° to 97° C. This very smoothly-flowing spring is, consequently, at this time 7° C. higher in temperature than the intermitting Geyser and Strokr, the temperature of which has been lately more carefully ascertained by Krug of Nidda. One of the most remarkable proofs of the origin of these hot springs being due to the percolation of cold meteoric water into the interior of the earth, and its contact there with a volcanic focus, was presented in the preceding century, in connexion with the volcano of Jorullo in Mexico, which was unknown to geography till after my South American journey. When this mountain suddenly made its appearance in September 1759, rising to a height of 1580 feet above the surrounding level, the two small streams Rios de Cuitimba y de San Pedro disappeared; but some time afterwards they made their appearance again, under the dreadful shocks of an earthquake, as hot springs. In 1803, I found their temperature 65°8 C.

The springs of Greece still flow apparently in the same places as they did in the times of Hellenic antiquity. The spring of Erasinos, two leagues south of Argos, in the declivity of Chaon, is even mentioned by Herodotus. At Delphi, the Cassotis (the so-called Wells of St Nicholas) still rises to the south of the Lesche, and flows under the Temple of Apollo; the Castalia, too, at the foot of Phædriadæ, and the Pirene at Acrocorinth, are there, as well as the hot baths of Ædepsos in Cubæa, in which Sulla bathed at the time of the Mithridatic war. I gladly adduce these particulars, because they forcibly remind us how, in a country exposed to earthquakes so frequent and so violent, the interior of our planet has been able to preserve its spring canals unaltered for 2000 years at least. The Fontaine Jaillissante of Lillers, in the department of the Pas de Calais, was bored in the year 1126, and ever since then has the water flowed uninterruptedly to the same height, and in the same quantity. The excellent geographer of the Caramanian coasts, Captain Beaufort, moreover, observed the same flame, fed by a stream of inflammable gas, which flows out in the district of Phaselis, which Pliny describes as the flame of Chimæra in Lycia.

The observations made by Arago in 1821, that the deeper Artesian wells are the warmer, was the first means of throwing a great light upon the origin of thermal springs, and led to the discovery of the law of the increase of the temperature of the earth according to the depth. It is remarkable, and only noticed in very recent times, that St Patricius probably Bishop of Pertusa, was led to a very correct view of the phenomenon which presented itself in the appearance of hot springs near Carthage, at the end of the third century. When questioned as to the cause of the boiling-hot water which poured out from the earth, he answered:—"Fire is nourished in the clouds, and in the interior of the earth, as Etna, and another mountain in the neighbourhood of Naples, inform you. The subterranean waters rise as through syphons; and the cause of the heat of hot springs is this: the waters that are more remote from the subterraneous fire shew themselves colder; those that flow in closer proximity to the fire, warmed by it, bring an insupportable heat to the surface which we inhabit."

As earthquakes are frequently accompanied by eruptions of water and watery vapour, so do we perceive in the salses, or the small mud-volcanoes, a transition from the alternating phenomena presented by jets of vapour and thermal springs to the great and frightful activity of hills that vomit forth lava. If these, as springs of melted mineral matter, produce volcanic rocks, so do the thermal springs that are charged with carbonic acid and sulphurous gas (and earthy matters), produce, by incessant precipitation, either horizontal beds of limestone (travertin), or they form conical hillocks, as in the north of Africa (Algeira), and the Banos of Caxamarca, on the western declivity of the Peruvian Andes. In the travertin of Van Dieman's Land, not far from Hobart Town, there are contained, according to Mr Charles Darwin, the remains of an extinct flora. By lava and travertin, two species of rock, the production of which goes on under our eyes, we here indicate the grand antithesis in geognostical relations.

Mud-volcanoes (salsen) deserve a greater share of attention than geologists have hitherto bestowed upon them. The extent of the phenomena has been overlooked, because in the two states in which it presents itself to us, the one of repose is that which has been principally dwelt upon; and in this state of repose mud-volcanoes often continue for centuries. The production of mud-volcanoes is accompanied by earthquakes, subterranean thunder, the elevation of a whole district of country, and the eruption of flames, which rise high, but last only for a short time. When the mud-volcano of Iokmali made its appearance in the peninsula of Abscheron, eastward from Baku, on the Caspian Sea (on the 27th of November 1827), flames burst forth, and blazed up to an extraordinary height for a period of three hours; for the next succeeding twenty hours they scarcely rose three feet above the surface of the crater that discharged the mud. The column of flame mounted to such a height near the village of Baklichi, westward from Baku, that it was seen at the distance of six (German) miles. Great blocks of stone, torn from their foundations beneath, were scattered widely around. Similar blocks are observed about the now slumbering mud-volcanoes of Monte Zibio, near Sassuolo, in the north of Italy. The second state, or that of activity, has continued for 1500 years in the mud volcano of Girgenti (Macalubi), in Sicily, which is described by the ancients. Many conical hillocks, of eight, ten, and even thirty feet high, though the height, as well as the form, of these varies at different times, are there seen arranged near one another. From the superior very small basin, which is full of water, along with the periodic escapes of gas, there are periodic streams of clayey mud discharged. The mud of these volcanoes is generally cold, but occasionally, as at Damak, in the province of Samarang, island of Java, it is of high temperature. The gases, which escape with a rushing noise, are also of different kinds—hydrogen gas, mixed with naphtha; carbonic acid; and, as Parrot and I ascertained, (in the peninsula of Taman and the South American Volcancitos de Turbaco), almost pure nitrogen gas.

Mud-volcanoes, after the first forcible outburst of flame, which perhaps is not common to all in the same measure, present the observer with a picture of an activity of the interior of the earth, that proceeds incessantly but feebly. The communication with the deep strata, in which a high temperature prevails, is speedily interrupted again; and the cold discharges of mud-volcanoes seem to indicate that the seat of the phenomenon, in its state of continuance, cannot be very remote from the surface. The re-action of the interior of the earth upon its outer crust is exhibited in a very different degree of force in the proper volcanoes, or burning mountains; in other words, in those points of the earth where a permanent communication, or, at all events, a communication that is renewed from time to time, is established between the surface and the deep focus of ignition. We must carefully distinguish between more or less exaggerated volcanic phenomena, such as earthquakes, hot springs and jets of steam, mud-volcanoes, the rising up of bell and dome-shaped unopened trachytic mountains, the opening of these mountains, or the upheaval of basaltic beds as craters of elevation, lastly, the rise of a permanent volcano within the crater of elevation itself, or amongst the fragments of its previous constitution. At different times, along with different degrees of activity and force, permanent volcanoes throw out jets of aqueous vapour, acids, glowing ashes and scoriae, and, when the resistance can be overcome, ribbon-shaped small fiery streams of melted earthy matter.

As a consequence of a great but local manifestation of force in the interior of our planet, elastic vapours raise either single parts of the crust of the earth into dome-shaped, unopened masses of felspathic trachyte and dolerite (Puy de Dôme and Chimborazo), or the upheaved strata are broken through, and inclined outwards, in such wise, that upon the opposite inner aspect a steep rocky edge is produced. This edge then becomes the boundary of a crater of elevation. When this has risen from the bottom of the sea, which does not, by any means, happen in every case, it then determines the whole of the characteristic physiognomy of the upheaved island. This is the origin of the circular form of Palma, which Leopold von Buch has described so carefully and so ably, as well as of Nisyros, in the Ægean Sea. Occasionally, one-half the ring-like edge is destroyed; and in the bay which the sea that has flowed in then forms, the social coral polypi establish themselves, and produce their cellular dwellings. Craters of elevation on continents are also frequently found filled with water, when they contribute to beautify the landscape in a peculiar manner.

Their origin is not connected with any particular mountain rock; they break out in basalt, trachyte, leucitic porphyry (Somma), or in doleritic aggregates of augite and Labrador. Hence the very dissimilar natures and external forms of this kind of crater edge. "No eruptive phenomena take place from such boundaries. Through them there is no permanent channel of communication established with the interior; and it is only very rarely that traces of still active volcanic power are discovered in the precincts, or within the circuit of such craters. The force competent to bring about such important effects, must long have accumulated, and gained strength in the interior, before it could have overcome the resistance of the superincumbent masses. On the formation of new islands, it raises up granular rocky masses and conglomerates (layers of tufa full of marine plants) above the level of the sea. Compressed gases escape through the crater of elevation; but a mass of such magnitude, thus upheaved, sinks down again, and closes forthwith the openings, which are only formed for such manifestations of force. No volcano is produced."

A proper volcano only arises where a permanent connection is established between the interior of the earth and the atmosphere. Here the reaction of the interior upon the exterior proceed for lengthened periods. It may, as in the case of Vesuvius (Fisove), be interrupted for centuries, and exhibit itself anew with renovated vigour. In the time of Nero, it was already customary, in Rome, to rank Ætna among the number of the gradually expiring volcanic mountains; Ælian, indeed, at a later period, maintained that the seamen began to see the sinking summit at a less distance on the high seas than formerly. Where the evidence of the eruption—I might say the old scaffolding—has been perfectly preserved, the volcano shews itself rising from a crater of elevation; there a high rocky wall, a rampart of greatly inclined strata, surrounds the isolated cone in the manner of a circus. Sometimes there is not a trace of this circus-like enclosure visible; and the volcano, not always conical in figure, then arises as an elongated ridge immediately from the elevated platform. This is the case with Pichincha, at the foot of which stands the city of Quito.

As the nature of mountain rocks, in other words, the combination or grouping of simple minerals into granite, gneiss, and mica-slate, into trachyte, basalt, and dolerite, independently of present climates, and under the most dissimilar zones, is still the same; so do we everywhere observe the same laws of formation proclaiming themselves in the realm of inorganic nature, laws according to which the strata of the crust of the earth stand in a certain relationship to one another, and under the influence of elastic forces, break through one another as dikes. This recurrence of the same phenomena is particularly striking in volcanoes. When the navigator, among the islands of distant seas, finds himself surrounded by palms and strange forms of vegetation, and no longer sees the same stars, in the individualities of the landscape, he still traces the characters of Vesuvius, the dome-shaped summit of Auvergne, the crater of elevation of the Canaries and Azores, the fissures of eruption of Iceland repeated and reflected. A glance at the attendant of our planet, the moon, generalizes still farther the analogy of formation here adverted to. In maps of the moon, we observe in our satellite, without atmosphere and without water, vast craters of elevation, which surround conical mountains, or support them on their circular walls; unquestionable effects of the reaction of the interior of the moon upon her exterior, aided by the influence of diminished gravity.

If, in many languages, volcanoes are properly designated Burning Mountains, it would still be a great mistake to suppose that they were produced by any gradual accumulation of the streams of lava that have flowed from them: their origin appears to be much more generally the consequence of a sudden upheaval of tenacious masses of trachyte or augitic rock, including polychromatic [Labrador] felspar. The measure of the upheaving force reveals itself in the height of the volcano; and this is so different, that in one case it is a mere hillock (as in Cosima, one of the Japanese Kuriles*); in another, it is a cone that rises to an elevation of 18,000 feet. It has seemed to me as if the relative height had a great influence upon the frequency of the eruptions; as if these were much more common in the lower than the loftier volcanoes. I will call attention to the following series:—Stromboli (2175 feet high), Guacamayo, in the province of Quiros, which thunders almost every day (I have frequently heard it in Chilo, near Quito, at a distance of 22 German miles), Vesuvius (3637 feet high), Ætna (10,200 feet high), the Peak of Teneriffe (11,424 feet high), and Cotopaxi (17,892 feet high). If the focus of these several volcanoes be at the same depth below the surface, a greater force will be required to raise the molten masses to a six or eight times higher level. Whilst the low Stromboli (Strongyle) has laboured incessantly, at least since the times of the Homeric traditions, and serves as a light-house to the Tyrrhenian Sea, guiding the seaman with its fiery signal on his course, the more lofty volcanoes are characterized by lengthened periods of repose. The eruptions of the greater number of the colossal volcanoes that crown the Andes, occur at intervals almost of a century apart: where exceptions to this rule have been observed,—and I long ago directed attention to them,—they may probably be connected with the circumstance, that the communication between the volcanic focus and the crater of eruption is not, and cannot be conceived to be, equally or permanently free in every volcano at all times. In the less elevated volcanoes the channel of communication may be closed for a season; so that their eruptions become rarer, without their being, on this account, any nearer to extinction.

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* *Vide* Jameson's Edin. Phil. Journal for an interesting account of Cosima, communicated by Tilesius.

With the consideration of the relation between the absolute height of volcanoes, and the frequency of their activity, in so far as this is externally visible, the place at which the lava flows out is closely connected. Eruptions from the crater are extremely rare in the case of many volcanoes; they generally proceed from the lateral fissures (as noticed by the celebrated historian Bembo, in the 16th century, whilst yet a youth), at places where the flanks of the uplifted mountain, in consequence of their shape and position, offer the least amount of resistance. Upon these fissures cones of eruption are occasionally raised. The larger of these are of such dimensions that they are often erroneously designated by the title of new volcanoes. Ranked side by side, they shew the direction of a fissure which has again become closed: the smaller ones frequently occur in groups, closely set together, and cover whole districts, as it were, with bell-shaped, or beehive-like, elevations. To the latter class belong the *hornitos* of Jorullo, and the cone of the eruption of Vesuvius of October 1822, of the volcano of Awatscha, according to Postels, and of the lava field near the Baidare mountains, in the peninsula of Kamtschatka, according to Erman.

When volcanoes do not rise free and isolated from a plain, when, on the contrary, they are surrounded by table-lands from 9000 to 12,000 feet* high, as in the double chain of the Andes of Quito, this circumstance may very well give rise to the fact, that the most violent eruptions, when red-hot ashes and scoriæ are thrown out with detonations that are heard for hundreds of miles around, are never accompanied with *streams of lava.* This is the case with the volcanoes of Popayan, of the lofty plains of Los Pastos, and of the Andes of Quito; the single volcano of Antisana, among the latter, perhaps excepted.

The height of the *cone of ashes*, and the dimensions and form of the *crater*, are the elements in the figure of volcanoes which more particularly impress upon each of them an individual character ; but of these elements, both the cone and the crater are perfectly independent of the magnitude of the whole mountain. Vesuvius is not one-third of the height of the Peak of Teneriffe, yet its cone of ashes forms one-third of the whole height of the mountain, whilst the cone of ashes of the Peak is only one-twenty-second of the entire elevation. In the case of another volcano of much greater height than the Peak, that of Rucu-Pinchincha, namely, the relations come nearer to those of Vesuvius. Of all the volcanoes I have seen in either hemisphere, Cotopaxi is that of which the conical form is the most regular and beautiful. A sudden melting of the snow of its cone of ashes indicates the proximity of an eruption. Before there is even any smoke visible in the attenuated strata of the atmosphere that surround the summit of the crater's mouth, the walls of the ash-cone are sometimes heated through, when the entire mountain presents the most threatening and ill-omened aspect.

The crater which, except in very rare cases, occupies the summit of the volcano, forms a deep, and often accessible, basin-shaped valley, whose bottom is subject to incessant changes. The greater or less depth of the crater is, in many volcanoes, an indication of the proximity or remoteness of an eruption. In the basin-shaped crater, extensive fissures open and close again alternately, through which, vapours of various kinds find vent, or small, rounded, and fiery openings, filled with molten matters are seen. The floor rises and falls, and in it are formed hillocks of ashes and cones of eruption, which occasionally rise high above the edges of the crater, and give the volcano its characteristic physiognomy for years; but, on the occurrence of fresh eruptions, they sink suddenly down, and disappear. The openings of these cones of eruption, which rise from the floor of the crater, must not, as is too frequently done, be confounded with the crater itself, which encircles them. When the crater is inaccessible, from its vast depth, and the perpendicular inward slope of its sides, as in the case of Rucu-Pichincha (14,946 feet high), one can still look down from the edges upon the summits of the monticules which rise within the cauldron-like crater, partially filled with sulphureous vapour. A more wonderful or grander natural prospect I have never enjoyed. In the interval between two eruptions, the crater of a volcano may exhibit no luminous phenomenon, but merely open fissures and jets of watery vapour; or hillocks of ashes, that can be approached without danger, are found upon its scarcely heated bottom. These often gratify the wandering geognost, without making him run any risk, by casting out glowing masses, which fall on the edges of the cone of scoriæ, their appearance being regularly announced by slight, and entirely local, shocks—earthquakes on a small scale. Lava occasionally flows from open fissures, or small fiery gorges, into the crater itself, without bursting through its walls, or overflowing its edges. But if it does break through, the molten spring generally flows smoothly, and in such a determinate direction, that the great cauldron-like valley, called the crater, can still be visited during the period of the eruption. Without a particular description of the form, and also of the normal structure of burning mountains, phenomena cannot be rightly comprehended which have been distorted by fantastical descriptions, and the various significations attached to the words *Crater*, *Cone of eruption*, and *Volcano;* or rather, to the indefinite and indeterminate use of these words. The edges of the crater sometimes shew themselves much less liable to change than might be expected. A comparison of De Saussure's measurements with my own, yields the remarkable result, in connection with Vesuvius at least, that the north-west edge of the volcano, the Rocca del Palo, may be regarded as having remained for forty-nine years

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* *French* feet in this and every other instance in the present paper.

(1773-1822) almost without change in its elevation above the level of the sea. Any difference that appears may be looked on as within the possible errors of measurement.

Volcanoes whose summits reach far above the limits of perpetual snow, like those of the Andes, present a variety of peculiar features. The sudden melting of the snow in the course of an eruption, not only occasions destructive floods, torrents in which heaps of smoking ashes are floated away on blocks of ice; but the accumulation of ice and snow goes on producing its influence uninterruptedly, and by filtration, into the trachytic rocks, even whilst the volcano is perfectly quiescent. Caverns are thus gradually formed on the declivities or at the foot of the burning mountain, and these become subterraneous reservoirs of water, which communicate in various ways, by narrow mouths, with the alpine rivulets of Quito. The fishes of these alpine streams multiply greatly, particularly in the gloom of the caverns; and then, when the earthquakes come, which precede all eruptions of volcanoes in the Andes, and the whole mass of the mountain is shaken, the subterraneous caverns at once give way, and pour out a deluge of water, fishes, and tufaceous mud. This is the singular phenomenon which the presence of the Pimelodes Cyclopum, the Prenadilla of the inhabitants of the lofty plains of Quito, attests. When, in the night between the 19th and 20th of June 1698, the summit of Carguairazo, a burning mountain 18,000 feet high, crumbled together, so that no more than two enormous rocky horns of the crater's edge remained, the country, for nearly two square miles, was desolated with liquid tuff, and argillaceous mud (lodazales), enclosing dead fishes. In like manner the putrid fever of the mountain town, Ibarra, to the north of Quito, which occurred seven years before, was ascribed to an eruption of fish from the volcano Imbaburnu.

Water and mud, which, in the volcanoes of the Andes, do not pour down from the crater itself, but from cavities in the trachytic mass of the mountains, ought not, consequently, in the strict sense of the phrase, to be reckoned among the number of proper volcanic phenomena. They are only mediately connected with the activity of volcanoes, nearly in the same measure as the irregular meteorological process, which, in my early writings, I have spoken of under the title of the *Volcano Storm*. The hot watery vapour which rises from the crater, and mingles with the atmosphere during the eruption, forms a cloud as it cools, with which the column of ashes and fire, many thousand feet in height, is surrounded. So sudden a condensation of vapour, and the production of a cloud of enormous superficial dimensions, increase the electrical tension, as Gay Lussac has shewn. Forked lightnings dart from the column of ashes, and the rolling thunder of the volcanic storm is then plainly distinguished from the rumbling in the interior of the mountain. This was well observed towards the end of the eruption of Vesuvius, in the month of October 1822. The lightning, which proceeded from the volcanic steam-cloud of the Katlagia burning mountain in the island of Iceland, according to Olafsen's account, upon one occasion (17th October 1755) killed eleven horses and two men.

On the Composition of Corals and the Production of the Phosphates, Aluminates, Silicates, and other Minerals, by the Metamorphic Action of Hot Water. By J. D. DANA.*

At the last meeting of this Association I alluded to the discovery of magnesia in corals, by B. Silliman junior, who had been engaged in chemical examinations of the corals of the Exploring Expedition. These investigations have been continued since, and lead to the conclusion that this is, beyond doubt, the source of the magnesia in magnesian-limestone. The analyses are not yet completed, and I cannot therefore give definite results.

Besides finding magnesia, Mr Silliman has made the more remarkable discovery of a large per-centage of phosphoric acid. Analogy had taught us that corals correspond, in their nature and relations, to the bones of higher animals; and we have now further evidence of this correspondence in their composition. The phosphates constituted, in some instances, 9 or 10 per cent. of the whole.

These facts seem to prove what has long been suspected, that the primary limestones and dolomites are altered sedimentary limestones, and that these limestones may be in part of coral origin. The so frequent occurrence of phosphate of lime (apatite) in this rock, is explained by the same discoveries, and corroborates this view of its origin. The little fluorine which apatite contains (6 or 8 per cent.), adds additional probability to these conclusions; for although fluorine has not yet been detected in these polyp remains by analysis, fluorspar is a common mineral in fossiliferous limestones, and often occurs in the cavities of shells and other fossils, as if proceeding from animal decomposition.

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* Read before the Association of American Geologists and Naturalists, at Washington, May 1844.

The same heat, then, that crystallized the limestone, crystallized also the apatite, splendid localities of which occur in the limestone of Northern New York, as well as in Orange county. It is universally admitted that this crystallization took place under the pressure of an ocean, and we may believe that the heat was distributed by means of its waters, both permeating and superincumbent.

These heated waters, like the hot waters of igneous regions generally—fine examples of which are seen in New Zealand, as well as the Geysers of Iceland—contained silica in solution. Through the action of this silica on the lime and magnesia, and on the oceanic salts present, may have been formed the minerals *serpentine*, *scapolite*, *pyroxene*, *tremolite*, &c., so common in granular limestone and dolomite. Another source of silica is found in the clay which sedimentary limestones often contain, hydraulic varieties of which sometimes include 40 per cent. A hydraulic limestone from the Helderberg, New York, analyzed by Professor Beck, contained 36 per cent., 28 per cent. of which were silica; and another from Rondout, Ulster county, New York, contained 24·50 per cent. of clay, 15·37 of which were silica, and 9·13 alumina. This may account for the occurrence of the above minerals without the infiltration of silica; yet the large amount of silica or siliceous minerals in some granular limestones, seems to require more than can be reasonably supposed to be supplied from this source. Moreover, the occurrence of silica in solution in regions of volcanic agency, is known to be frequent, and cannot in all instances be excluded for accounting for these metamorphic changes and crystallizations.

The alumina of the same clay in impure limestones uniting with the magnesia and silica, may have given rise to the *aluminous varieties of hornblende;* and the iron often present, may have contributed towards producing the *dark ferruginous* varieties. The formation of mica may be explained on the same principles.

The presence of fluorine has already been alluded to; and this, with the silica and magnesia, appears to have produced the *chondrodite*, another very abundant mineral in our dolomites.

The alumina and silica with potash or soda from heated volcanic waters might have originated crystals of feldspar, albite, &c.

Where spinels have been formed, the alumina of the altered magnesian limestone may have predominated over the silica, and thus have given rise to this mineral—an *aluminate of magnesia*. Spinel is usually associated in Orange county, New York, with chondrodite. And it seems probable that the little fluorine present, at once took possession of the silica, and formed fluosilicic acid,—for the attraction between fluorine and silica is known to be one of the strongest in chemistry,—and thus combined, produced, by uniting with magnesia, the mineral *chondrodite*, which is a compound of silica, fluorine, and magnesia. Where spinels are not found, as with rare exceptions is the case in St Lawrence county, New York, it may be owing to the large amount of silica present, or the absence of fluorine. Chondrodite is nearly as rare a mineral in Northern New York as spinel.

Remarks on Professor Pictet's Treatise on Palæontology. By Professor AGASSIZ.

The publication of a general work on Palæontology by an entomologist,* is calculated to excite our surprise, especially when, as is the case with our author, that entomologist occupies a place in the first rank, both on account of his learning and his writings. Entomology is indeed the most exclusive of all the branches of natural history; and it has always been a matter of remark, that the naturalists who have devoted themselves to the study of articulated animals neglect more or less the other divisions of the animal kingdom. Latreille himself has not succeeded in fixing the attention of the learned on those of his works which do not treat directly of entomology. This isolation is undoubtedly to be regretted; but it is rendered intelligible if we reflect that the prodigious number of insects, the variety of their metamorphoses, and the very marked peculiarities of their organization, demand the whole attention of those who attempt to advance this department of science. Thus, if I had to analyze an entomological work of M. J. Pictet, in order to recommend it to the attention of the scientific world, I would content myself with stating that it was the production of the same pen which had given us the "*Recherches pour servir à l'Histoire et à l'Anatomie des Phryganides*," and the "*Histoire Naturelle des Insectes Neuroptères*." But M. Pictet has entered a new arena. Under the title of "*Traité élémentaire de Paléontologie ou Histoire Naturelle des Animaux Fossiles*," he has just published the two first volumes of a work intended to embrace the history of all the types of the animal kingdom which existed before the present creation. An attempt of this kind requires the possession of such varied knowledge, that, before giving an account of the new publication of my learned friend, I think it necessary to state his claims to the confidence of palæontologists. M. Pictet is Professor of Zoology and Comparative Anatomy in the Academy of Geneva, and has neglected none of the branches of natural history. His notices on the "*Animaux Nouveaux ou peu connus du Musée de Genève*" prove, that the characters of the higher animals are as well known to him as those of articulated animals. The osteological collections with which he has enriched the museum under his superintendence, bear witness to his zeal in obtaining all the necessary materials for the realization of the plan he has projected. Moreover, the collections of fossils of the Museum of Geneva, of Deluc, of Saussure, and of Necker, the products of that epoch when Geneva raised monuments to her glory in all the domains of science, will be an inexhaustible mine for the new labours which M. Pictet has undertaken.

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* *Traité Elémentaire de Paléontologie ou Histoire Naturelle des Animaux Fossiles considérés dans leurs rapports Zoologiques et Geologiques.* Par F. J. Pictet, Professeur de Zoologie et d'Anatomie Comparée à l'Académie de Genève.

The perusal of the two first volumes has convinced us that this work will accomplish the object intended. It is by no means a mere compilation which the author presents to us, but it is in truth an animal kingdom of the epochs anterior to the present, elaborated in a zoological point of view, and founded on a thorough knowledge of all previous investigations. Without making a parade of fastidious erudition, the author shews, in every page of his work, that he is master of his subject; and, by a happy choice of the examples he quotes, he inspires us with that kind of confidence which is at once produced by all works that are well conceived and well executed. Another merit to which we are anxious to render justice, because it is essential in a book of this nature, is the clear and precise exposition of the most complicated phenomena, and the talent so peculiarly possessed by the author, of bringing out, with distinctness, the essential points of the subject of which he treats, so as invariably to leave on the mind of the reader an exact conception of the questions under discussion. Although more particularly intended for the student, this work is also of a nature to interest that more numerous class of readers who are anxious to keep up their knowledge of the investigations of modern science. Professional naturalists themselves will consult it as a good summary of the present state of palæontology, and one which is much superior to all the works of this description hitherto published.

The first chapter is devoted to the history of palæontology. We have afterwards an exposition of the nature of fossils, and of the manner in which they have been deposited; a chapter on the classification of formations, another on the distribution of fossils in the various formations, and on the succession of animals at the surface of the globe; and, lastly, an exposition of the zoological principles of the classification of fossils. The author next proceeds to the special history of the Mammifera. It might be wished that, in this general preliminary view, the information on geology properly so called, had been somewhat more precise: for, however correct the statements generally are, we can easily perceive by the omission of some proper names, and by the order in which those quoted are placed, that the work of M. Pictet is essentially a zoological and palæontological treatise, and not a history of the structure of the globe; and as such has been the object proposed to himself by the author, we cannot make it a matter of reproach to him, that more is not said on geological questions.

Almost the whole of the first volume is devoted to the history of the Mammifera. It is not my intention to follow the author in the details of the enumeration of the genera, the families, and the species, which it has been necessary for him to characterize; and I shall content myself with saying, that the characters which he has given invariably correspond to the present state of our knowledge, and that the engravings which accompany his descriptions, render them easy of apprehension, without encumbering the work. The methodical enumeration of all the known types of the Mammifera, compared, in an ideal manner, with their living analogues, will, doubtless, contribute much to render apparent the laws of the succession of those animals in the series of formations; and the author will, no doubt, bring them prominently forward, in a tabular form, in the last part of his book, in which he is to treat of the application of Palæontology to the study of the ages of nature.

Having made these general remarks, let me now proceed to a few criticisms or details. M. Pictet very judiciously rejects the opinion of M. De Blainville, who imagines that he has proved that the fossil bears of caverns are identical with our recent species; but I think that M. Pictet goes too far when he affirms that all the best investigations of careful zoologists have shewn that the fossils are different in each formation. In representing the question in this manner, he forgets that M. Deshayes, who, of all modern conchologists, is the observer most entitled to our confidence, asserts that a very large number of the tertiary species are identical in the different formations of that great epoch, and that eminent geologists have adopted the determinate proportions of tertiary species which are identical with living ones, as a distinctive character of the different tertiary formations: he also forgets that Ehrenberg, whose splendid investigations have thrown so much light on the mode of formation of the sedimentary strata, maintains the identity of hundreds of species occurring in the chalk, in the tertiary series, and at the present day. Let it not be imagined that I am opposed to M. Pictet's view of the subject; for, on the contrary, I am, like him, convinced that these identifications are inaccurate: but it is to prove this at some future time that our investigations ought to tend; for, far from having received general assent, this mode of viewing the question has hitherto been adopted by M. D'Orbigny alone, who, in his classical work on French Palæontology, was the first to prove that each of the members of the cretaceous series has a peculiar fauna, just as I have asserted to be the case in regard to the Jurassic and tertiary formations.

In speaking of fossil seals, M. Pictet forgets to quote the finest known example, viz., a fragment of a jaw figured by Scilla in his work *De Corporibus Marinis Lapidescentibus*, 1752, plate xii., fig. 1. He ought also to have been able to ascertain, from the letters of H. von Meyer, published in Leonhard and Bronn's Journal (letters containing important palæontological information, and which have been generally neglected in this volume), that the *Anœma Oeningensis* of Cuvier is a true Lagomys,—a fact which I have ascertained by the inspection of the original specimen figured in the *Recherches sur les Ossements Fossiles*. Von Meyer's letters would likewise have furnished our author with some useful information respecting the fossil cetacea of the valley of the Rhine, and especially as to the genus Halianassa. Lastly, it must also be stated, that M. Pictet would have found in Major Mitchell's Travels in the interior of New Holland, the description and the figures given by Mr Owen of the fossil species of Didelphis found in the caverns and the osseous breccias of Wellington Valley. All these, however, are but slight omissions, which cannot affect the general character of the work.

Our knowledge of fossil birds is still so imperfect, that the summary of it given by M. Pictet is necessarily confined to the enumeration of the localities where traces have been met with. A monograph on this branch of palæontology is still a desideratum; and it is to be hoped that the beautiful investigations of Mr Owen on the genus Dinornis, and on some remains of birds from the London clay, will induce him to prosecute his researches on this subject with the same success which has attended all his palæontological labours. I may take this opportunity of remarking that the *Gryphus Antiquitatis* of Schubert, which, for a quarter of a century, has been considered as a vulture of colossal dimensions in all manuals, was, in fact, founded on the fossil horns of the rhinoceros.

The second volume of M. Pictet's treatise commences with the history of fossil reptiles. We have here, for the first time, a systematic summary of all the investigations relative to the fossil remains of these animals, which, as the author justly remarks, exhibit such extraordinary forms in some of the species, such gigantic dimensions in others, and a distribution so different from that which obtains at the present day, that they must necessarily attract, in a very high degree, the attention both of geologists and zoologists. M. Pictet insists, with great reason, on the complete absence of reptiles in the primary [Transition] period. Their appearance at the commencement of the secondary epoch, seems to me to be the most prominent character to which recourse can be had, in the arrangement of primary [Transition] and secondary formations in more extensive groups. I cannot subscribe to the opinion of the English geologists, who include the Permian system among the Palæozoic formations. The general view given by M. Pictet of the succession of reptiles is very well conceived: he places in a very clear point of view the fact (the importance of which can be properly appreciated only by a zoologist), that along with the very diversified types which succeed one another in the series of formations, there are others not less ancient, which resemble, in a surprising degree, those of the present creation. M. Pictet shews himself to be equally competent to draw just conclusions from all these facts, and thus to present incontestible proofs in opposition to the idea of the transition of species. For my own part, I cannot doubt but that zoologists, by basing their opinions on anatomy and physiology, will soon entirely annihilate the vain theory of the derivation of existing beings from a small number of primitive types; but I think that M. Pictet deceives himself, when he sees, in the whole facts relative to the history of fossil reptiles, a complete demonstration of the difference between the living and the tertiary species. We still know too little of tertiary reptiles, to justify us completely in drawing such a conclusion; although, I again repeat, that I am myself convinced of the truth of that assertion. The endeavours of M. Pictet to group in a natural manner so many extinct genera of reptiles, which are often very imperfectly known, seem to me to merit the approval of naturalists; and his family of Dinosaurians will undoubtedly be adopted. As I do not wish to enter into greater details regarding this class than respecting the Mammifera, I shall here limit my observations to some critical details, which rather affect the investigations quoted from others, than our author himself. Thus the remains of the Trionyx, which M. Kutorga assigns to the sandstone of the neighbourhood of Dorpat, are in fact bones of fishes of the genus Asterolepis, which I had described under the name of Chelonichthys, before I was aware that they had already received an admissible appellation.

With regard to the genus Saurocephalus of Harlan, which that author includes among the reptiles, M. Pictet has committed a mistake, which it is only necessary to point out in order to rectify. The animal is twice described in his book; first of all, and erroneously, among the reptiles; and afterwards in its proper place among the fishes, in the family of the *Sphyrénoïdes*, where I had arranged it.

We now come to the class of fishes. As my own researches regarding these fossils have been the principal basis of this portion of M. Pictet's treatise, I shall abstain from speaking of them at any great length. I may be allowed simply to remark, that if there be any merit in having accomplished the original investigation, I have experienced a lively satisfaction in seeing the result of such long-continued and arduous labours presented in so concise and interesting a form. The reflection that my researches have now begun to supply, in the history of organized beings, a chapter hitherto entirely neglected in most of the treatises of this kind, is the most delightful recompense which I can receive for my exertions. I experience only one regret, and that is, that the results of my investigations are incomplete. Even now, however, M. Pictet might have filled up some of the blanks which he has indicated, had he received, in sufficient time, my memoir on the fossil fishes of Sheppey, and my monograph on the species found in the Devonian system. But though we include that information, and although I am already acquainted with 1700 species of fossil fishes, the history of that class of animals is still so far from being completed, that, reasoning upon considerations which it would take too long to develop in this place, I have arrived at the undoubted conclusion, that in estimating at about *thirty thousand* the number of species of fishes which have been successively entombed in the beds constituting the solid crust of our globe, we are still far below the truth; for such are the riches of the creation which we endeavour to reconstruct by our researches, that it seems to increase in magnitude and in extent, in proportion as we make progress.

The second volume of M. Pictet's treatise contains the commencement of the history of the Mollusca; but as that portion of the work is still incomplete, we shall give no account of it at present.

Palæontologists will, doubtless, look with eagerness for the third volume of the treatise now before us, as it will contain, besides other matter, the history of articulated animals, a subject to which the author has more particularly devoted his attention.

Let us hope that the pleasure which M. Pictet must have derived from his palæontological labours will induce him to study, in a special manner, fossil insects,—a branch of the subject which no one is capable of examining with greater precision than himself; and that he will enrich science with an iconographical work, representing the numerous remains of that class which have hitherto remained unrecorded by a special historian.*

Observations on the Railways of Belgium.† By JOHN ANDERSON, Esq., F.R.S.S.A. (With Two Plates.) Communicated by the Royal Scottish Society of Arts.

If the proposition hold true that the state of the arts is a test of civilization, it must not only be interesting but instructive to know the progress they have made amongst nations. It is, at least, in such a belief that I lay before the Society what little information I acquired concerning the railways of Belgium, during a tour throughout that country in autumn last. I would have done so at an earlier part of the session, but being desirous of authenticating my observations with the Government documents, and of giving any statistical information of interest they might contain, I thought it better to wait until I had received the Reports presented to the Chambers in 1843.

Belgium was, in ancient times, the great emporium of Europe; but, through her own misfortunes, and the invasion of enemies, she became for more than 300 years "war's favourite play-ground," and trade and manufactures fled from her soil. Since the revolution of 1830, however, a mighty change has been effected in her prosperity. Through the policy of a wise and liberal government, arts and manufactures have been encouraged, and much done towards establishing once more her ancient grandeur. To aid this object, national expositions were established, and premiums awarded for approved works of art; duties were levied upon foreign imports, and every means employed to stimulate the people to extend her manufactures. Thus encouraged by her rulers, the Belgians, naturally possessing a lively and industrious spirit, adopted many of the modern improvements of England, and established factories for the making of machinery

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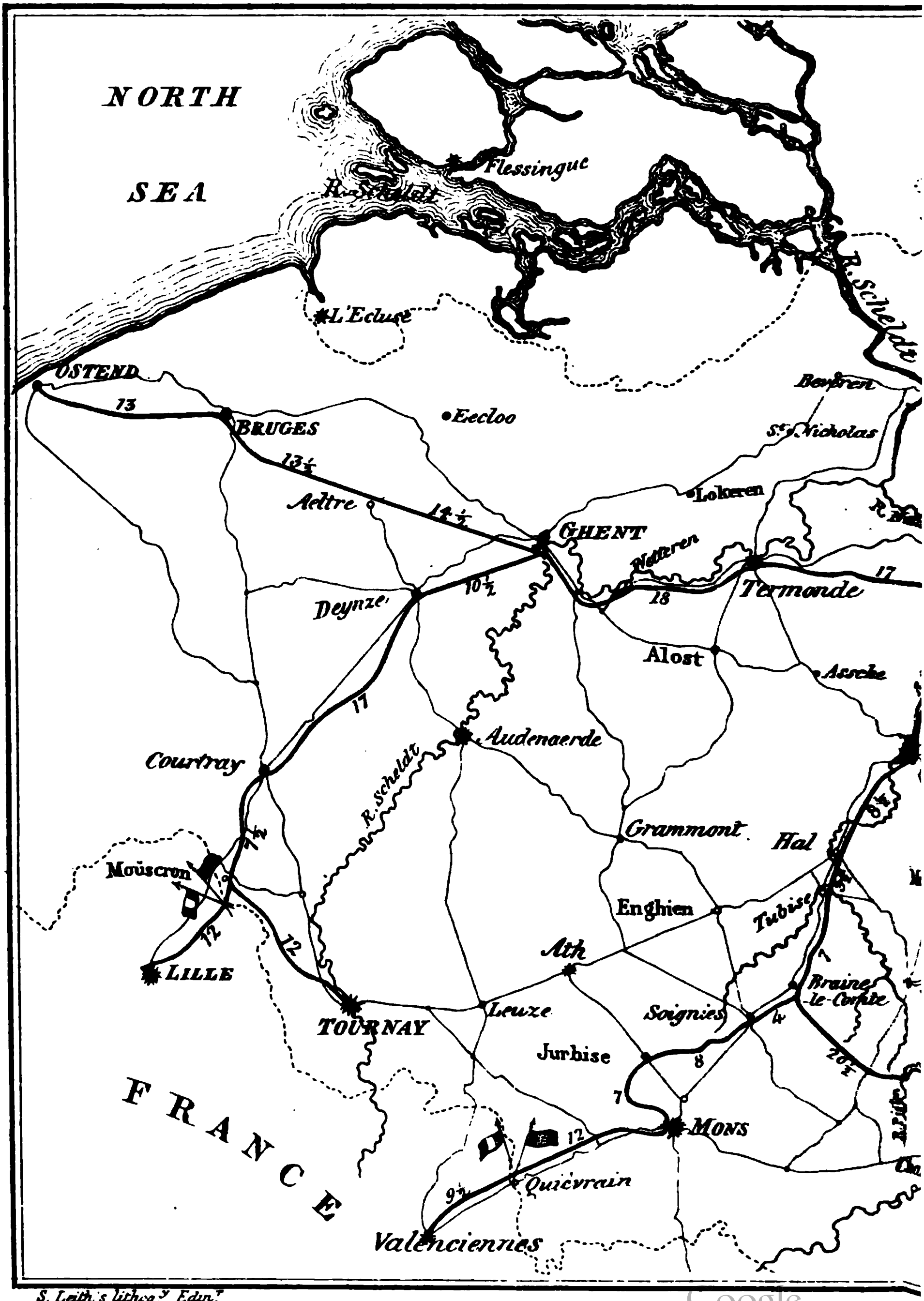
* *Bibliothèque Universelle de Genève*, No. 112, 1845.

† Abridged from a Paper read before the Society on 10th June 1844.



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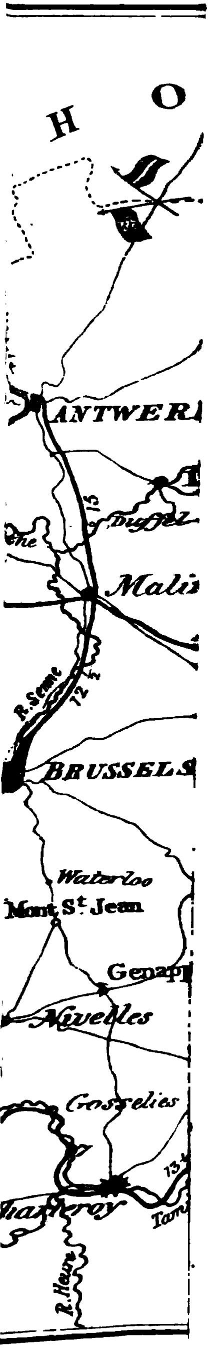

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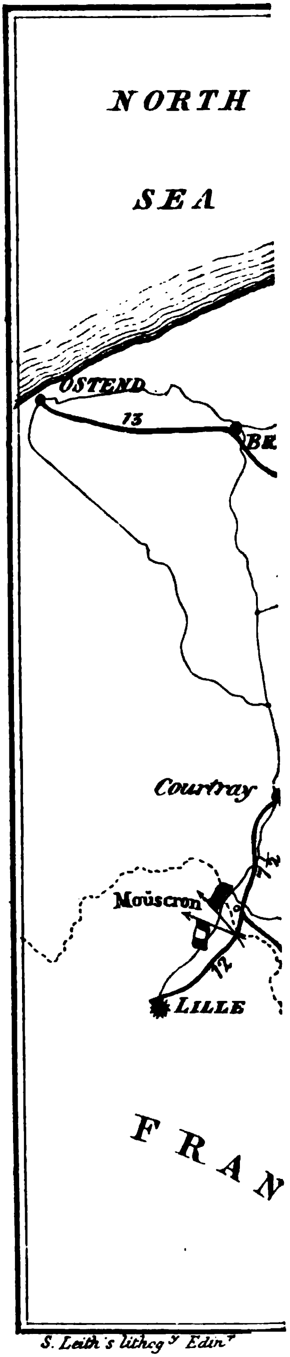

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and the manufacture of cloth. This, however, did not complete their improvements. The means of communication being slow and tedious, it became necessary to establish a more expeditious mode of transit; and for this purpose an admirable system of railroads has been formed by the Government, which, as in every other case, has been productive of great advantage to every branch of industry.

The bill authorising their construction was passed in the Chambers in May 1834, and an extension of the system into other provinces granted in May 1837. Malines (Plate IV.) was chosen as the central station, through which two lines pass from the extremities of the country at right angles to one another. The line, from north to south, unites Antwerp with the French frontiers and Valenciennes, passing through Brussels, Braine-le-Comte, and Mons; and that from east to west connects Ostend with the Prussian frontiers and Cologne, passing through the towns of Bruges, Ghent, Louvain, Tirlemont, Liege, and Verviers. These lines, with the exception of those which proceed from Ghent, through Courtray to the French frontiers, and Lille, and from Braine-le-Comte by Charleroy to Namur, and to Givet in France, when the project is carried out, are considered the principal lines in Belgium. Among the minor lines may be classed the one from Mouscron to Tournay, and the branch from Landen to St Trond, and to Hasselt by Weyer, with a branch to Diest, when the contemplated plan is carried into effect. Powers were also granted by the law of 1837 to carry out the system into the province of Luxemburg; but these powers were withdrawn in 1840, on the ground that, while highly advantageous for the province, it would not be profitable for the state.

The Government greatly benefited their system by aiding the extension of the line from West to East to Cologne, and also encouraging the construction of the lines from Ghent to the frontiers, and from Brussels to Quiévrain, to the towns of Lille and Valenciennes in France. By this means easy and expeditious international communication has been obtained, and traffic in every branch greatly increased. The extension of the line to Cologne was of itself calculated to realize the greatest benefits. Previously, the only mode of communication for foreign merchandise to Germany and

Switzerland was by the slow and tedious navigation of the Lower Rhine and the Meuse; but by the junction of the Rhine with the Scheldt, by railway communication, the traffic was expected to be carried through Belgium. The line was only opened from end to end in October last; so that time has not yet been given to verify the anticipations of the Belgian rulers. But it must be allowed that the scheme was good, the more especially when we consider that a great European line has been projected from Cologne to Dusseldorf, Lippstadt, Minden, Hanover, Brunswick, and Magdeburg, to unite with the Prussian railroads, and from Dresden, the south-eastmost extremity of their system, to join the line from Brunn to Vienna by Prague. A line has also been proposed from Vienna to Pest, to pass by Baden, Oldenburg, and Raab, and another to proceed nearly north from a point in the Vienna and Olmutz railway to Cracow, Radomsk, and Warsaw. Thus, two of the principal cities, Berlin and Vienna, and a great part of the most thickly populated countries in Europe, will be in direct communication with the German Ocean, making the Belgian railroads from Prussia to Ostend or Antwerp a portion of the great European line. There is at present in course of being constructed a line from Lille to Paris by Douay, Arras, Amiens, and Pontoise, with a junction from Douay to Valenciennes; several sections of which are expected to be opened next year, which will likewise be of great advantage to Belgium.

The accumulated length of the Belgian railroads amounts to 348·122 miles. They consist partly of a double and partly of a single way of 4 feet 8½ inches betwixt the rails of the track, and a distance of 6 feet 6½ inches betwixt the railroads. It is impossible to determine the actual expense of construction until the different lines are completed; but in 1842, after the lines from Brussels to Antwerp, Malines to Ostend, Malines to Ans, Landen to St Trond, and the section of Brussels to Mons, on the line from Brussels to Quiévrain, had been finished, and the remainder of the lines estimated, the anticipated cost was L.5,330,915, or L.15,313 per mile. This expense, however, is not nearly in proportion to the extent of the different lines, but varies very much, notwithstanding the generally flat nature of the country. The following table gives the length and cost of the different lines, the stations thereon, and the total cost of the whole establishment:—

Line	Length of Lines.	Cost of Lines.	Cost of Stations per Line.	Total Cost.	Cost per Mile.	Remarks, with reference to the Estimates.
		£	£	£	£	
Brussels to Antwerp (including branch from the station of Borgerhout to the Scheldt).........	29·028	303,378·12	228,061·48	531,439·60	18,308	Double way.
Malines to Ostend.................	76·025	633,350·24	84,847·76	718,198·00	9,447	Double way to Ghent.
Malines to Ans (including branch to the Canal at Louvain.........	55·100	743,458·92	42,658·08	786,117·00	14,267	Double way.
Ans to the Prussian frontiers (including branch to the interior of Liege)..................	29·500	1,240,303·47	132,400·00	1,372,703·47	46,532	Double way to Verviers.
Landen to St Trond............	6·350	48,336·72	6,823·08	55,159·80	8,686	Single way.
Ghent to Courtray	27·130	170,923·88	17,900·00	188,823·88	6,960	Single way.
Courtray to the French frontiers	9·359	131,000·00	8,920·00	139,920·00	14,950	Double way.
Mouscron to Tournay.............	11·890	111,560·00	10,520·00	122,080·00	10,267	Single way.
Brussels to Quiévrain............	50·127	648,875·94	99,011·96	747,887·90	14,920	Part double way.
Braine-le-Comte to Namur.......	50·699	563,239·39	75,800·00	639,039·39	12,604	Single way; but embankments and works of art made for the establishment of a double way.
Junction of Stations at Brussels	2·914	29,546·04	....	29,546·04	10,139	
	348·122	4,623,972·72	706,942·36	5,330,915·08	15,313	
Material of Transport	...	...	...	823,921·12		
Total General Expense	...	...	...	6,154,836·20		

Up to the end of 1842, 271·587 miles had been constructed; and in the autumn of last year the first way, and probably more, of the remaining lines had been completed. On taking an average of the cost of the British railways, it will be found that those in England cost fully double, and those of Scotland and Ireland fully a third, more than those of Belgium. Even the French railways, on the following average, are constructed at nearly double the expense of the Belgian lines :—

	Per Mile.
The line from Lyon to St Etienne cost, in round numbers, .	L.19,000
... ... Paris to Versailles, ...	26,000
... ... Paris to St Germain, ...	39,000

In the Belgian lines, both parallel and *fish-bellied* rails are used. There is nothing particular in their mode of laying them down. The ballasting consists of sand and gravel, and, from various circumstances, formed a considerable item in the expenditure :—

			s.	d.	
Between	Waremme and Ans,	it cost	8	5½	per cubic yard.
...	Louvain and Tirlemont	...	6	9¼	...
...	Tirlemont and Waremme	...	5	6¼	...
...	Deynze and Courtray	...	5	1	...
...	Landen and St Trond	...	4	7	...
...	Malines and Antwerp	...	3	11¾	...
...	Malines and Termonde	...	3	10¾	...
...	Ghent and Deynze	...	3	10	...
...	Bruges and Ostend	...	3	6¾	...
...	Malines and Louvain	...	2	8½	...
...	Termonde and Ghent	...	2	8	...
...	Ghent and Bruges	...	2	7½	...
...	Brussels and Tubise	...	2	7½	...
...	Malines and Brussels	...	1	11¾	...

The rails were furnished in 1834-35-36-37, and at different times in the following years, in lengths of 15 feet, 16·4 feet, and 14·8 feet. Those of 15 feet were furnished of different weights, weighing 40·1 lb., 39·7 lb., 35·3 lb., 43·7 lb., 54·5 lb. to the lineal yard; those of 16·4 feet weighing 50·4 lb., and those of 14·8 feet weighing 50·4 and 48·8 lb. to the lineal yard. The whole rails are of the manufacture of the country, with the exception of about 200 tons, which were brought from England in 1834, to serve as models. Their price during the first four or five years varied very much; no doubt from the competition to which the extensive demand gave rise. The ton of rails, which could be furnished at Malines, for instance, in 1834, for L.14 : 12 : 6, rose to L.15 : 4 : 6 and L.18 : 1 : 6, and descended again to L.17, 1s., L.13, 16s., and came even so low, in 1840, as L.10 : 0 : 6, but rose again the same year to L.11 : 3 : 6. Those, however, produced in 1840 were much inferior to the rails first manufactured in the country. Until 1838, chairs, keys, and spikes, were furnished with the rails; but since that time the contractors have bargained to supply them separately. The ton of chairs, in 1834, was supplied at L.10, 7s., but rose the year following to L.10, 15s., and, in 1836, to L.12, 16s., L.13, 4s., and L.14, 4s.; and, in general, fluctuated with the price of rails. Keys and spikes, in 1834, cost L.22, 7s. per ton, and rose the following year to L.24 : 3 : 6, L.24 : 11 : 6. In 1836-37, they varied from L.28, 9s. to L.30, 1s.; and, in 1838, came down, after many fluctuations, to L.24 : 7 : 6 and L.23 : 19 : 6. In short, the cost, in general, likewise varied in proportion with the rails and chairs. These articles were chiefly furnished by Cockerill of Seraing, Gordons & Co. of Cardiff, Dupont of Fayt, Henrard of Couillet, Lamarche of Ougrée, De Dorlodot of Acoz, Marcellis of Liege, Goffart of Monceaux, Delloye of Houyoux, Michiels of Ougrée, Lentz De Tiennes of Coron-Meuse, Destombes of Hourpes, and Gendebien of Chatelineau.

Notwithstanding the number and extent of the different lines, there are few works of art of any magnitude, or places of any great engineering difficulty, except upon the line proceeding from Ans to the Prussian frontiers, where the railway descends the valley of the Meuse to Liege, and remounts the valley of the Vesdre to Verviers. However, it may not be uninteresting to glance at the most important undertakings.

Proceeding from Antwerp to Brussels, the only work of art of any importance on the line is the Bridge of Duffel, over the river Nèthe, which is 262·5 feet in length, and 22·9 feet in breadth. It consists of five elliptical arches of 19·7 feet of span each, one of which is made of cast-iron, and is used as a draw-bridge for the free navigation of the river. The railway also, in its course to Brussels, passes over three bridges on the river Senne, two of which are placed at Sempst and Eppeghem, of two arches of 20·5 feet of span each, and one at Laeken, of one arch of 39·4 feet of span. The expense of constructing this line ought to have been comparatively little, but, from inexperience or oversight, the section from Brussels to Malines was made upon so low a level that it was often overflown by the Senne, which greatly damaged, and sometimes even perfectly obstructed, the railway. The rails, moreover, were too weak, and the sleepers made from white and pine wood. From these circumstances, it became necessary to raise the railway at least upwards of a foot and a half, and protect the banks, and form viaducts through which the waters could flow. The old rails were nearly all thrown aside, and others of greater strength laid down, and the sleepers subjected to M. Boucherie's process for the preservation of wood. Indeed, every means were taken to remedy the evils, but not without incurring great expense.

Between Brussels and Quiévrain the construction of the railway becomes more difficult, from the uneven nature of the country through which it passes. The ground also on several sections consists of peat, and bogs are not uncommon in this quarter of the country. On this account it has been necessary to build a greater part of the bridges on piles, and raise the railway in some places 13 feet. The works of art on the line are numerous, but none of them are of any great importance. The most important undertaking is the tunnel of Braine-le-Comte, which is 16·4 feet of span, and 25·7 chains in length. The bridges, with but one exception, consist of a single arch, and the largest is about 39·4 feet of span.

The same difficulties which occurred on the line from Brussels to Quiévrain also presented themselves on the line from Braine-le-Comte to Namur, but the works are of more importance. At Godarville there is a tunnel of 27·3 chains in length, and upon the river Sambre alone 14 bridges, 13 of which are of a uniform model of 3 arches, of an elliptical curve, of about 33 feet of span each. There is also in the valley of Sennette a viaduct of 9 arches of 29·5 feet of span each, and three bridges upon the canal of Charleroy, besides four upon the Piéton, and one upon the water of Heure. The bridges which cross the railway are of a span of 29·5 feet, and of a height just sufficient to allow the locomotives to pass under them.

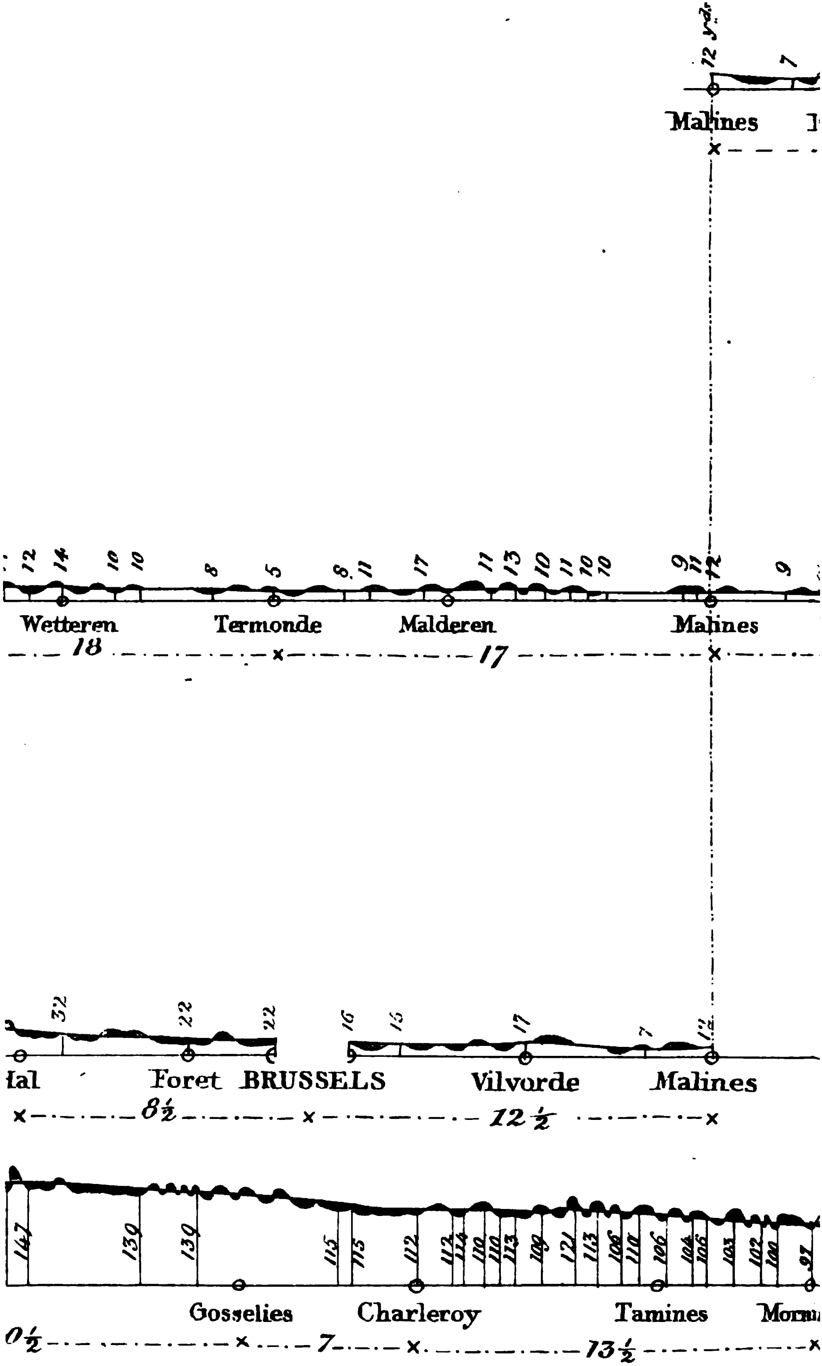
The line from Ghent to the frontiers of France, and the branch from Mouscron to Tournay, with the exception of one or two of the sections, are of very easy construction. The largest work of art is that in the low grounds of Meir, which consists of a series of 16 arches of about 16·4 feet of span each. Near Tournay there is a bridge of 56·4 feet of span, and also one of 30 feet upon the canal of Espierre. Betwixt Courtray and the French frontiers there are several embankments and cuts of considerable importance. The largest embankment and cut are both in the valley of Mouscron, the former of which is 32·4 feet at its maximum height, and 1 mile 21·9 chains in length, and the latter 17·2 feet at its maximum depth and 30·82 chains in length.

But of all the lines in Belgium, the most favourable, considering the distance, for the formation of a railroad, is that from Ostend to Malines. This arises principally from the level nature of the country. However, on this line it has also been necessary to raise and strengthen the embankments, to prevent damage arising from the overflowing of the rivers. In consequence of this, the banks in the meadows of Tronchiennes, betwixt Ghent and Bruges, have been considerably strengthened; and several aqueducts and bridges have also been constructed betwixt Malines and Termonde for the same purpose. The bridges upon the line are very numerous, several of which are constructed of iron, and serve as draw-bridges. The largest bridge is that upon the Scheldt at Ghent, which has been made for four tracks, one forming the double way towards Ostend, and the other towards Courtray. There is also a bridge of two arches over the Senne at Hombeeck, and a viaduct at Malderen.

From a short distance from Malines the railway begins to ascend to Ans. The works upon the line, though numerous, are light. The greatest undertaking is the tunnel of Cumptich, which has been lately constructed for the double way. It is entirely built of brick, and is 20·6 feet in height, and 45·73 chains in length. The heavy works, however, of the Belgian railroads only begin at Ans, where the railway descends into the valley of the Meuse.

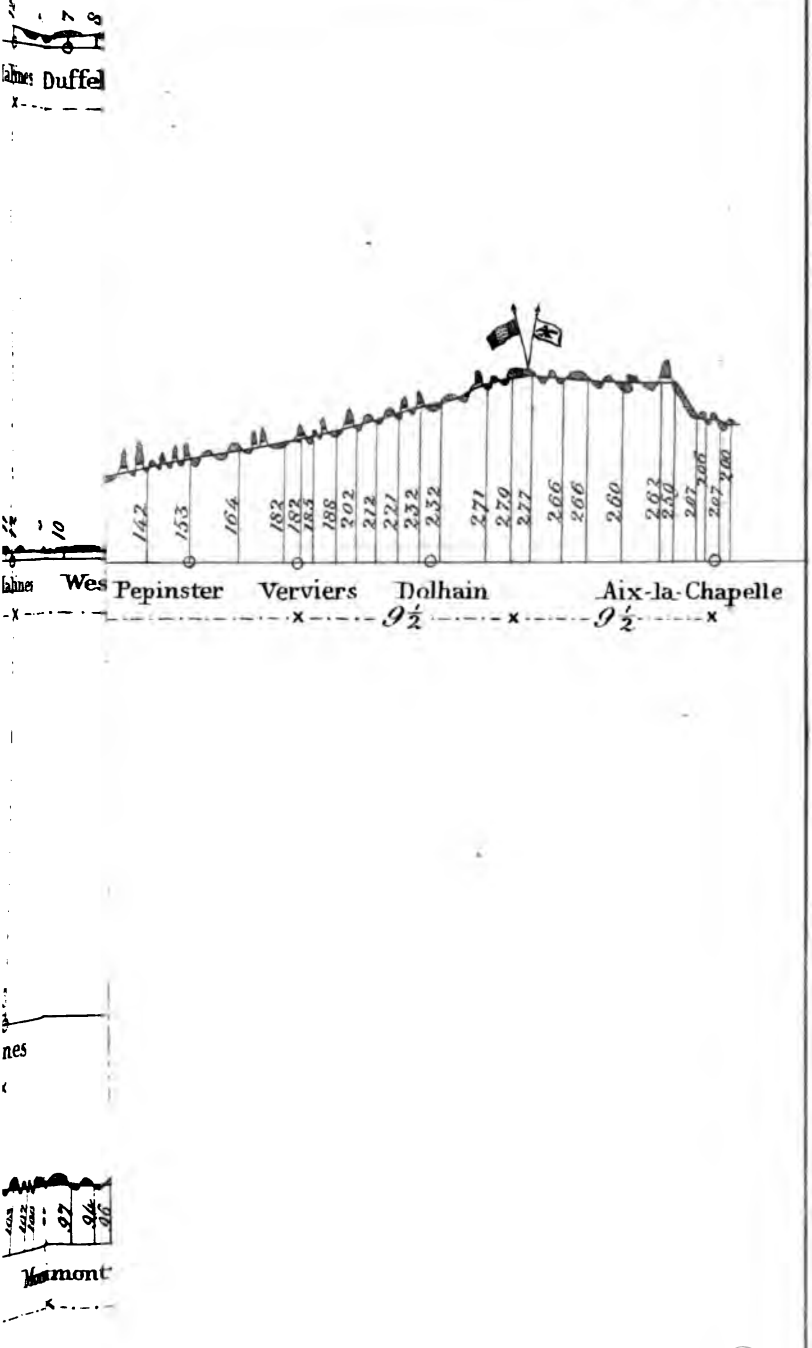
Ans stands upon the west bank of the valley of the Meuse, about 581 feet above the level of the sea; and Liege is situated in the bottom of the valley, about 358 feet below Ans. The distance betwixt Ans and the Meuse at Liege is 4 miles 9 chains, thus making on the length of the line the general gradient about 1 in 60. To descend this valley was a matter of no little difficulty, and it was only after many years' study, in which time numerous projects were examined, that the administration saw the necessity of descending it by inclined planes. The plan adopted by them consists of two inclined planes of equal lengths, with a platform or level space of ground, on which the engines are placed, situated at the bottom of the first and the summit of the second incline. The platform is about 16⅜ chains in extent, and the inclines 1 mile 18⅜ chains each of length, of a rise of 1 in 36, both of which are constructed with a double way, the one being employed for ascending, and the other for descending. Referring to the section, (Plate V.) the railway proceeding from Ans describes a curve of 1 mile 37 chains of radius, and descends the first incline. Having crossed the platform, it descends the second incline, and arrives at the principal station of Liege. The trains descend the inclined planes by gravitation, their velocity being regulated by drags attached to the carriages and waggons. Two fixed engines, of 160 horse-power each, are placed on the platform for raising the trains, which is accomplished by means of an *endless rope*. Both engines being situated close together, are supplied with steam from the same boilers. The system of signals, we are told, they employ, is somewhat novel:—A tube of fully one inch diameter is laid along the railway. Each of its extremities communicates with the interior of a bell, the mouth of which is immersed in water. Into the top of the bell a whistle is fixed, which, as in the case of the locomotive whistle, acts by the vibration of the metal. When it is required to communicate the time of departure of any of the trains from either station, the signal-man has only to shut off communication with the whistle, and immerse the bell further amongst the water. The air in the one bell will thus be forced, by pressure, through the tube into the other bell at the further end of the tube, and will escape by passing through, and at the same time acting upon, the whistle.

Plate



72 yds
Malines
Wetteren
Termonde
Malderen
Malines
Hal
Foret
BRUSSELS
Vilvorde
Malines
8½
12½
Gosselies
Charleroy
Tamines
0½
13½

Fig. V.



S. Leith's lithog.y Edin.r

Nothing strikes the traveller so much with astonishment, when he descends the valley of the Meuse, and enters that of Verviers, as the contrast the face of the country presents to that which he a few minutes ago left. The scenery, indeed, as soon as he leaves Ans, is entirely changed. Instead of the flat and monotonous country through which he has just passed, he is ushered into a finely varied district of hills and valleys. The number and extent of the different works of art he observes, tell him also of the nature of the country through which he is passing, and the difficulties which the engineer encountered in the execution of this part of the national system of railroads.

The works of art betwixt Liege and the frontiers are more numerous, and much more difficult in execution, than on any other line in the country. Upon the Meuse, between the banks Val-Benoît and Bac-en-Pot, there is a bridge of five arches, of 65·6 feet of span each; and also one upon the Ourthe of three arches, of 52·5 feet of span each. At the zinc manufactory of Angleur, there is a series of twenty-four arches, twelve of which are interior, and twelve exterior, to the work; the first of which were established for communication, and the second for the flowing of the Ourthe during its inundations. On the section betwixt Chênée and Pepinster there are ten tunnels, making a total length of 1 mile 29·36 chains; and on that betwixt Pepinster and the frontiers, nine tunnels, of a total length of 67·1 chains. Great difficulty arose in executing the tunnels betwixt Chênée and Pepinster, from the nature of the hills through which they pass, and the unexpected appearance of water. Among the most difficult was the tunnel of Halinsart, which is 31·66 chains in length, and the longest of the whole of that section. In addition to these works, there are, however, 18 bridges, generally of from 90 to 100 feet of span each, and numerous viaducts, &c. The largest viaduct is placed across the valley at Dolhain, and consists of 20 arches, of nearly 33 feet of span each, from 56 to 59 feet in height. This work has a most commanding appearance,, is well executed, and the most extensive throughout the whole lines of railroad. Besides the works of art on this line, there are numerous difficult cuts of considerable length and depth. Indeed, the formation of a railroad in this part of the country presented many objects of difficulty, and some parts of the line may be almost said to be formed of a continuation of viaducts and tunnels.

It may be remarked, that, in the execution of the different works of art throughout the different lines, the workmanship is inferior to that of similar undertakings in this country; and that also in their construction, due attention has always been paid to the fortifications of the towns by which the railway passes.

The curves and gradients, as necessarily follows, from the extent of the different lines, vary very much, and present many of the results which arise from their existence on railways in general. The radii of the principal curves are as follows:—3·73 chains; 9·44 ch. (both on the branch of Louvain to the canal); 9·94 ch.; 12·43 ch.; 17·4 ch.; 18·14 ch.; 19·88 ch.; 24·85 ch.; 29·83 ch.; 34·8 ch.; 37·28 ch.; 39·77 ch.; 43·74 ch.; 44·74 ch.; 49·71 ch.; 54·68 ch.; 59·65 ch.; 62·14 ch.; 67·1 ch.; 69·59 ch.; 72·58 ch.; 74·56 ch.; 79·54 ch.; and 1 mile 4·5 ch.

The most important gradients are:—

1. That towards Waremme, at the station of Landen, of 1 in 244, of 2 miles 39 chains in length.
2. That towards Tirlemont, at the station of Louvain, of 1 in 250, of 3 miles 58 chains in length.
3. That between Tubise and Braine-le-Comte, of 1 in 200, of 5 miles 47 chains in length.
4. That on the branch from Louvain to the canal, of 1 in 71, of 32 chains in length.
5. That betwixt Jurbise and Braine-le-Comte, of 1 in 250, of 4 miles 3 chains in length.
6. That betwixt Mons and Jurbise, of 1 in 250, of 6 miles 42 chains in length.

The stations throughout the different lines are numerous, and, in general, neat and commodious buildings. Antwerp, Brussels, Malines, and Ghent, are reckoned of the first order, and contain the warehouses and arsenals for provision and material. Ample accommodation is set apart in them for passengers; one large room being always devoted to first and second, and another to third class, passengers. The next stations in importance to these are, Bruges, Termonde, Louvain, and Tirlemont; and then the minor stations upon the different subdivisions of the line. Malines was, from the very first, chosen as the central station through which the greatest number of passengers was expected to flow; and it was also fixed upon as the workshop for the repairs of the heavy machinery, and of the railways in general throughout the country, the workshops at any of the other stations being only of secondary importance. But, notwithstanding its many advantages, Brussels has become the principal station, and draws one-fourth of the receipts of the whole of the different lines. In consequence of this unexpected result it became necessary to build a more extensive station at the north of Brussels. The stations, with the exception of Ostend, Bruges, and Ghent, are placed without the towns, for the purpose of evading the local taxes, which can only be accomplished by placing them beyond the boundaries of the excise. Tickets for the trains are issued from the windows of the different offices; and, to avoid confusion during a crowd, stalls are erected, through which the passengers pass one by one, receive their checks, and return by a passage parallel to the one by which they entered. If the traveller has luggage exceeding 44 lb. weight, he has to proceed to the luggage depot, where it is weighed, and he is charged a trifling sum per lb. Upon paying this sum he receives a ticket with a number marked upon it, corresponding to one which is put upon his luggage. From this time he sees no more of his property until he arrives at his destination, where it is brought from the luggage-waggon, and the number marked upon it called out by one of the officers in attendance, who returns it to its owner on presenting the ticket which he had received. If, however, he wishes it placed entirely under the responsibility of the administration during his journey, he must forward it to the station at least ¼ of an hour before the starting of the train. Luggage under 44 lb. weight, if deemed necessary, can also be confided in the same way by passengers to the administration, at an equal rate of charge per lb. For luggage lost which is entered in this manner, the administration pays the proprietor a compensation for his property at the rate of 2s. 2d. per lb. This is an admirable system of management for preventing confusion and loss of property, and one which should be adopted on every railway.

Several tables of fares have been drawn up at different times, but none of them have given satisfaction. A Commission was appointed in August 1841 to watch their effects, and to report upon their results. Without entering on the working of the different tariffs, it may not be uninteresting to state that the fares were raised in 1839, and that a great diminution of passengers was the result. They have since undergone several fluctuations; and by the last tariff, they were fixed, with one or two exceptions,* at

1·14 pence per mile for the first class carriage
·93 ... ... second ...
·56 ... ... third ...

or at the rate of nearly one shilling per ten miles for the first class; tenpence for the second; and sixpence for the third. For intermediate stations or distances of less than 6⅕ miles, not indicated by the table, 7⅕ pence is charged for the first; 4⅘ pence for the second; and 2⅘ pence for the third class carriages. These prices are doubled for stations distant more than 6⅕ miles, and for intermediate minor stations distant more than thirty-one miles, the price of the first principal station following is charged. Passengers were allowed, previous to 1843, to take luggage along with them into the carriages, free of expense, varying from 44 lb. to 55 lb.; but since that time it has been fixed at 44 lb.; and they can also, by paying *one-tenth* per cent. on the value of their goods, have them insured. Children under eight years of age, accompanying their relations or friends, are carried free of charge, provided they do not occupy the places of passengers. The mails are carried gratis, and the military at half the common fares.

Small merchandise, carried by the passenger trains, costs ·39 pence per cwt. per mile, or about 7¾ pence per ton. The smallest charge is about sixpence. For carriages of four wheels, 9·27 pence per mile; and for carriages of two wheels, 6·18 pence per mile is charged. The following is the table for horses and cattle:—

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* The exceptions consist principally in this,—that the prices were slightly raised for the sections from Brussels to Malines, and thence to Termonde, and that they were lowered for the third class on the south line.

For 3 horses,	9·27	pence per mile.
... 2 ...	7·72	... ...
... 1 ...	6·18	... ...
... waggon of little cattle, or from 5 to 8 oxen or cows,	7·42	... ...
... 3 or 4 oxen or cows, 5 to 10 swine or calves, 11 to 20 sheep,	6·18	... ...
... 1 or 2 oxen or cows, 1 to 5 swine, 1 to 10 sheep,	4·63	... ...

To encourage this branch of traffic, 25 per cent. is deducted for complete waggon loads.

The locomotive engines, at the 1st of January 1843, were 129 in number, 42 of which were made in England, and the remainder in Belgium. Of these, 95 are in good working order, and 34 undergoing repairs. In addition to these, however, 10 were in course of being constructed, which will make, in all, 139. The following table gives the makers' names, and the number each has made, with the diameter of the cylinders and driving wheels:—

Makers' Names.	Diameter of Cylinders.	Diameter of Driving Wheels.	No. of each Size.	No. by each Maker.
England.				
Stephenson,	11 inches,	5 feet,	8	30
	12 ...	5 ...	6	
	12¼ ...	5½ ...	1	
	12½ ...	5½ ...	7	
	14 ...	4½ ...	7	
	14 ...	5 ...	1	
Londgridge and Co.	12½ ...	5½ ...	10	10
Fenton and Murray,	12 ...	5 ...	1	1
Sharp, Roberts, and Co.,	12 ...	5 ...	1	1
Belgium.				
Cockerill,	11 ...	5 ...	12	69
	12 ...	5 ...	27	
	12½ ...	5½ ...	20	
	14 ...	4½ ...	10	
Soc. St-Léonard,	12 ...	5 ...	4	7
	13 ...	5½ ...	3	
Soc. du Renard,	12½ ...	5 ...	1	11
	12½ ...	5½ ...	5	
	13 ...	5½ ...	5	
Total,				129

The coke required for the consumption of the locomotives is manufactured at Monplaisir, Malines, Antwerp, Ghent, Ostend, Ans, and Hal; and costs at these places respectively, L.1 : 4 : 2½, L.1 : 3 : 11¼, L.1 : 7 : 6¾, L.1 : 3 : 8¼, L.1 : 5 : 2½, 17s. 0¾d., and L.1 : 1 : 5, per ton. The quantity consumed in 1841, in running over 927,080 miles, was 29,303 tons, or 70·80 lb. per mile. This is including, however, the quantity required for the *reserve* and *lighting*, which amounted to 4399 tons, and which, if deducted, will make the consumption 60·17 lb. per mile. In 1842, the distance run over was 987,432 miles, and the total quantity of coke consumed was 28,317 tons, or 64·24 lb. per mile. The quantity required for the *reserve* and *lighting* was 5635 tons, and which, if deducted, will make the consumption 51·46 lb. per mile.

Besides the locomotive engines, there are 127 tenders, 514 carriages, 1223 different sorts of waggons for merchandise, and 273 waggons for railway use, such as the conveyance of coke, and embanking operations. The whole are either in good working order, or undergoing repair. There are in course of construction, 15 tenders, 84 carriages, and 654 waggons for merchandise. The carriages consist of three classes, as they do in this country, but are much more commodious, and, in some cases, vastly superior in comfort. For example, second class carriages possess not only windows, but the seats are cushioned, and almost as comfortable as those of the first class, though, perhaps, a little less elegant. Even third class carriages have covered seats, and very often roofs supported upon perpendicular iron rods fixed at the corners of the carriages. The seats are placed transversely, and without any proper mode of entrance, which is a great inconvenience to passengers; and the doors are, in every case, unlocked, but are held close by a catch, which can be opened and shut from either side of the carriage.

The rate of travelling, generally, is about 20 miles per hour; but on some lines, on account of the gradients, it varies from 19 to 25 miles per hour. Each train is accompanied by a couple of guards; and, five minutes before the appointed time of leaving any of the principal stations, a bell rings for preparation, and, shortly afterwards, another for starting.

After the first bell has rung, the passengers are allowed to proceed from the station to their seats; and, shortly after the second, the guard, at one end of the train, sounds a bugle, which, if answered by the other, announces that all is right, and the train proceeds.

The gradients, it will be observed, from what has been said about the rate of travelling, affect the speed of the trains very materially. The greatest gradient, with the exception of that betwixt Ans and Liege, is 1 in 71 on the branch from Louvain to the canal. A locomotive, of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, can ascend this slope with a train of three loaded and three empty waggons, of a total weight of about 44¼ tons; but a locomotive of a 14 inch cylinder, with coupled driving wheels of 4½ feet, can ascend it with six loaded and three empty waggons, of a total weight of about 69 tons, the rate of travelling in both of these cases being three miles per hour. From a curve in several parts of this line, however, of 3·73 chains of radius, it is thought to be more convenient to work it with horses. A strong horse upon this incline can draw a waggon of about 6 tons weight, at the rate of 2⅛ miles per hour.

On the inclination betwixt Tubise and Braine-le-Comte of 1 in 200, two trains, of 16 and 17 carriages each, with a total weight of 88½ to 98½ tons, and a locomotive of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, were unable to proceed in unfavourable weather. At another time, equally unfavourable, an engine of the same size took up two trains of 13 and 11 carriages each, with a total weight of about 88½ and 78¾ tons, with great difficulty. On the inclination betwixt Jurbise and Soignies of 1 in 250, two trains, of 12 and 13 carriages each, with from 78¾ to 88½ tons, and an engine of the same dimensions, could not ascend. A third, however, with 13 carriages of 88½ tons, succeeded in mounting the slope.

From these observations it was concluded, that the greatest weight with which an engine of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, can ascend either of these inclinations, is from 88½ to 98½ tons in ordinary weather, but otherwise with only from 73¾ to 78¾ tons. With the same size of cylinder, however, either of these inclines can be ascended with about 69 tons, at a velocity from about 12⅜ to 15½ miles per hour; or, with an engine of a cylinder of 14 inches diameter, about 108¼ tons can be taken up, at the rate of about 12⅜ miles per hour.

On the inclination betwixt Louvain and Vertryck of 1 in 250, the following trains ascended with difficulty in unfavourable weather:—

Locomotive.	Inch cylinder.		Feet.	Carriages.	Tons total weight.
1	14	with coupled driving-wheels of	4½	20	137¾
1	14	... ...	...	23	147½
1	12	not coupled ...	5	16	98½
1	14	coupled ...	4½	18	137¾
1	14	... ...	...	24	147½
2	14	... ...	...	39	270¾
1	14	... ...	...	18	118
1	14	... ...	...	22	137¾
1	14	... ...	...	22	137¾

From these experiments it was concluded, that a locomotive of a 14 inch cylinder, and coupled driving-wheels of 4½ feet diameter, could ascend this incline with difficulty in ordinary weather, with from 137¾ to 147½ tons, but during times of snow with only 69 tons; and a locomotive of a 12 inch cylinder, with driving-wheels of 5 feet diameter, not coupled, could ascend, in ordinary weather, with from 78¾ to 98½ tons, and in times of snow with from 44¼ to 49 tons. They ascend this slope regularly, however, with trains of 73¾ and 108¼ tons, including the weight of the locomotives of 12 and 14 inch cylinders, about the rate of 15½, and from 12⅜ to 15½ miles per hour.

Considering the novelty of the system of communication, comparatively few accidents have taken place in any part of the country; and these, in almost every case, have been through the imprudence of the parties who suffered. None of the accidents, either, have been to any fearful extent, except the late melancholy catastrophe on the Antwerp and Brussels line. From the opening of the first of the lines, in May 1835, to the 1st of January 1843, in the course of which time 14,431,524 passengers had travelled, and when, undoubtedly, from inexperience, danger might have been anticipated, only 44 persons met with their death, 26 of whom were officials of the establishment. As nearly as can be ascertained, 7 of the other unfortunate individuals were passengers; 4 were killed from walking upon the railway; and 7 committed suicide, by voluntarily placing themselves in the way of the loaded trains. Besides these fatal events, there were 59 persons injured, 36 of whom were officials of the establishment; 22, as far as we can learn, were passengers; and 1 a person walking upon the railway. Separating the accidents occasioned by the sufferers themselves from those attributable to the railway administration, 37 of the deaths and 31 of the injuries rank under the first head, and 7 deaths and 28 injuries under the second head. The following is a tabular account of the accidents, and the means by which these were occasioned:—

	DEATHS.		INJURIES.	
	Attributable to the imprudence of the parties themselves.	Attributable to the railway administration.	Attributable to the imprudence of the parties themselves.	Attributable to the railway administration.
Passengers,	6	1	14	8
Persons walking upon the railway,	4	0	1	0
Officials of the establishment,	20	6	16	20
Suicides,	7	0	0	0
Total,	37	7	31	28
Total general,	44		59	

It is satisfactory to state, that, on comparing the above number of passengers with an equal number who travelled by the common diligence, the casualties by railway communication are fewer, and the safety of the passengers generally much greater.

The whole railway business is under the management of a director, who is under the control of the Minister of Public Works. It is divided into four branches—namely, the general management of the whole system; the management of the lines; the locomotive department; the traffic of the railway; and the management of the stations. The first of these, generally speaking, includes the other three, one of which consists in the management of the lines, and the finishing and constructing of new works of art; another in the traction of the trains, the manufacture of coke, and the management of the arsenal at Malines, including the workshops for repairing the locomotives and carriages; and the third, in the management of the stations and the passenger and merchandise traffic. Over each of these four departments a functionary, entitled, Engineer-in-Chief, or Inspector of Administration, is placed, who furnishes an account of the proceedings of his department to the Minister, and makes such proposals to him as he thinks necessary or advantageous. The propositions he submits are sent for examination to the Council or permanent Commission of Ways and Bridges. Besides the surveillance exercised by the director, and the agents under his orders, the Minister causes all the works to be examined by the Inspector-General, and by the Divisionary Inspector of Ways and Bridges; and with the documents received from the different departments, renders an elaborate report of the whole business annually to the Chamber of Deputies.

The government have, at various times, voted sums to the amount of L.6,010,562, at different rates of interest, for defraying the expense of the construction of the railways,—which, with the exception of L.40,654, has been devoted to that purpose. Up to the 1st of February 1843, L.5,311,960 have been expended or set apart, leaving a balance of L.657,948. When the government sum shall have been expended, the outlay per mile will be L.17,149; on which sum, although a little below the definite estimates elsewhere given, the rate of interest has been calculated. In concluding these remarks upon the railways, it may not be uninteresting to state the amount of traffic throughout the different lines, and the return made to government for their spirited undertaking. For this purpose, the following table is given, shewing at once the length of the railways, the number of passengers, the amount of receipts, the expense of working the lines, and the returns, in each year, up to the 31st December 1842:—

Years.	Number of miles opened at 31st December.	Number of Passengers.	Amount of Receipts.	Expense of working the lines.	Difference betwixt the receipts and the expense of working the lines.	Per centage on the lines in operation.	Estimated per centage on the whole Government outlay.
1835	12½	421,439	10,760	6,751	4,009	7·79	2·83
1836	27⅛	871,307	33,005	17,245	15,760	8·28	4·12
1837	88¾	1,384,577	56,679	47,594	9,085	1·96	0·95
1838	159	2,238,303	123,913	109,946	13,967	1·21	0·65
1839	192	1,952,731	169,993	123,159	46,834	2·68	1·62
1840	206¼	2,199,319	213,406	130,180	83,226	3·44	2·43
1841	234¾	2,639,744	249,053	174,153	74,900	2·76	2·8
1842	271½	2,724,104	298,462	188,013	110,449	3·2	2·63

Upon taking the average of the number of passengers since the opening of the first line in 1835, there will be found to be 9 per cent. of the first class, 27 per cent. of the second class, 63 per cent. of the third class, and 1 per cent. of military.

CUPAR-FIFE, *25th May* 1844.

On Fossil Fishes, particularly those of the London Clay.

By Professor AGASSIZ.

The fossils of the London clay have long since attracted the attention of geologists, from the considerable number and variety of their species belonging to all classes of the animal and vegetable kingdom, as well as from the beautiful state of preservation in which a large number of them occur. Since the researches of Sowerby on the shells of this deposit, several memoirs of great merit have appeared on the fossils of different classes. Professor Owen has described, with his usual acuteness, the reptiles, birds, and Mammalia which are met with scattered here and there in the layers of this deposit, and his erudite investigations have thrown quite a new light on the relations which connect the fossil creatures of this formation with the species of the present epoch. The beautiful work of Mr Bowerbank on the fruits of this deposit is well known to every one. The Ichthyology alone had been almost entirely neglected; not that there is any scarcity of fossil fish, for there is no known fish-bed which counts so many species, and no collection of tertiary fossils of England which does not, at least, contain some specimens. The want of knowledge which has hitherto prevailed with respect to the fish of Sheppey is solely owing to the very peculiar difficulties which the study of their fragments present. Elsewhere, and especially in the strata of transition and secondary rocks, in the slates, limestones, and sandstones, the ichthyolites are more or less entire; and it is seldom that a fragment does not present several parts of the body, different portions of the fins, of the scaly coating, of the opercular apparatus; or, if indeed the pieces themselves are not preserved, their impression indicates at least the general form and the outlines of the body; so that, with a sufficient knowledge of living fish, of their form and external characters, it is possible to arrive at accurate and strict determinations. Moreover, the majority of older fish have osseous scales harder even than the bones; and the mode of their arrangement (*enchevêtrement*) contributes to preserve the general form of the fish even when the bones have disappeared and the other parts have become destroyed.

Classifications in ichthyology have hitherto been based on external characters; among others, on the form, number, and position of the fins, the structure of the scales, the relations of the different parts of the body to each other, the dentition, the arrangement of the opercular pieces, &c. If we glance over the most esteemed works of our time on the natural history of fish, none but external characters will be met with in the diagnoses of the families, genera, and species, easily conceived, and sufficient, indeed, for the proposed object. If I speak of the voids which this branch of science, to which I have devoted myself for so many years, presents, it is not that I wish to detract the least in the world from the merit of so many works which the most distant posterity will still regard as master-works of sagacity, application, and research; but it is that, having selected a special branch of ichthyology, I have perhaps been enabled more than others to perceive what remains to be done in this vast domain. This is especially true with respect to the Sheppey fish, which have none of those forms and of those fantastic characters peculiar to the majority of the fish of the older formations; all in them, on the contrary, recall to mind the fish of our present oceans, so that before having made a minute study of them, we should be inclined to think that we had to do with recent species. Their fragments are buried in a more or less indurated clay, which sometimes presents the hardness of calcareous rocks, while, in other localities, it has remained perfectly soft. The greater number of the fish have rotted in this fine clay, their bones have separated, and the soft parts have been replaced by clay. Now, since it is no longer Ganoids with cuirassed body covered with interlocked bony scales, but Cycloids and Ctenoids with thin fragile scales, their coating has not been sufficiently solid to preserve the integrity of their form and outline. Their body has become decomposed, their fins have become detached, their scales disaggregated, and of the greater number only the cranium has remained, preserved entire, owing to the soldering of the osseous pieces composing it. If, instead of belonging to fish, these skulls were derived from Mammalia or reptiles, it is to be presumed that all possible advantage would be taken of them, and that the palæontologist would have no trouble in determining their relations, since for these classes the materials for comparison are not wanting, the points of departure are fixed. The characteristic features of the skulls of the Mammalia and Reptilia are known; the variations which such a bone, such a crest, such a groove may undergo in such and such a family are understood; and already, at the first glance, it is possible to ascertain whether the animal under consideration is carnivorous, ruminant, or solipedal.

But nothing is more variable than the forms of the cranium and of the heads of fish. The multitude of bones and of spines which serve for the attachment of the muscles, the infinite variety of forms in the families themselves, imparts such a diversity to the crania of fish, that the ichthyologist frequently despairs of being able to reduce them to their respective types, and in fact a comparative craniology of fish does not exist. There is no one that I know who can tell at first sight whether such and such a cranium belongs to a Percoid, to a Sparoid, or to a Chetodontal type.

The great majority of the fossils of Sheppey consists, we have said, of detached vertebræ, or of isolated crania. The latter, moreover, are generally deprived of the bones of the face; the jaws, the opercular and branchial apparatus are wanting, and most frequently only the cranial envelope, properly so called, remains; and very often, indeed, even this has lost the whole of the anterior portion, the snout formed by the union of the nostrils and of the vomer, so that there is no other point to start from than the cranium, deprived of all its appendages. To determine these fragments, I have followed the same process that nature employed to place these fossils in the state in which we meet them. Ordinary skeletons, such as are contained in the museums of natural history and comparative anatomy, would not have sufficed for my purpose. I began, therefore, by preparing a certain number of detached bones of different marine fish, and I possess at present a hundred detached crania with the other bones separated,—a collection which I am daily increasing. As it is of importance that the different bones of the cranium be not isolated, but that the envelope which they form should preserve its natural form, all these crania have required the greatest care in their preparation; and in this a great difficulty occurred, arising from the manner in which the bones of the cranium are joined in fish. In the other Vertebrata this junction is effected by sutures; the crenulate and dentate margins correspond, and it is easy to reconstruct a dismembered cranium. In fishes, such is not the case. Most frequently the bones are applied on an internal cartilage form, frequently very thick, sometimes thinner; and their margins, if indeed they touch, are applied the one on the other by their faces, or separated by broad bands of cartilage. The general form of the cranium is, therefore, frequently entirely different from what it would be if we were to attempt to reconstruct the cranium with isolated bones, approximating these latter by their margins. In the fish from Sheppey the cartilages have disappeared, the clay has taken their place, but not entirely, so that the crania have the form which the skulls of half-dried recent fish acquire. It is this point of desiccation which I have endeavoured to attain in my crania of recent fish.

These means of comparison might appear sufficient, did we not meet with another difficulty which is opposed to the direct application of these materials to the object in view. The fish of Sheppey belong to the tertiary deposits; they consequently approach types at present existing. But it is known, and the investigation of the fish of Monte Bolca has sufficiently proved, that the more the families and genera ascend to the older deposits, the less number of representatives do they possess in the present creation, and these representatives are, moreover, in general met with in distant regions. Thus, of all the large family of the Saroids which formerly peopled the sea, but two representatives remain in the fresh waters of the present creation, while the most numerous families of our epoch, the *Siluri*, the *Cyprini*, the *Gadi*, and several others, have few or no representatives among fossils. It is, therefore, not among the most common fish of our coasts that we must search for the analogues of the fossil tertiary fish. On passing in review the ichthyolites of Monte Bolca, we meet with a quantity of fish belonging to families containing few members in our seas, the representatives of which live, for the greater part, only in the Indian Sea, or the Southern Ocean, such as the *Squamipennæ*, the *Aulostomata*, the *Gymnodonts*, the *Sclerodermata*.

To determine accurately the fish of Monte Bolca, or of the other tertiary deposits, I have been able to call to my aid the materials collected in museums, and especially the skeletons in the Museum of Paris. The comparisons had principally to be made with the body and the fins, which are tolerably well-preserved in those fossils, and which are exhibited by the skeleton. To determine the fish of Sheppey, I was obliged to have at my disposal a collection, not less rich, of dismembered skeletons, detached crania, and of isolated bones; but it is only possible to form such a collection slowly and at great expense, especially when the person who forms it lives at a distance from the sea, and has at his disposal but a small museum, destined rather to receive typical specimens of genera than series of specimens of the same species.

If, notwithstanding these difficulties. I am able to offer at present a tolerably complete sketch of the fossil fish of Sheppey, I owe it to the kindness of English geologists; in particular of Lord Enniskillen, of Sir Philip Egerton, of Dr

Buckland, of the Rev. Mr Hope, of Messrs Bowerbank, Cumberland, the Directors of the British Museum, of the College of Surgeons, &c., who have all eagerly communicated to me the original fragments from their collections, which I have thus been able to compare directly with the crania of recent fish. This investigation has thus been made on entirely new bases. The labours of former ichthyologists have scarcely afforded the least assistance; and even the great works on Comparative Anatomy of Cuvier, Meckel, and so many others, have rarely furnished sufficient information; for their object is, to make known the bones of the cranium and of the head in general, to indicate the part which these bones take in the formation of the osseous skeleton of the head, to describe the variations they may undergo in composing the most extravagant types, and, lastly, to point out the analogy of the bones with those of other classes of Vertebrata, rather than to indicate the precise form of each bone in all the genera. The same is the case with respect to the great anatomical discussions at the commencement of the present century, which related to the analogy of the head of fish with that of the other Vertebrata, rather than to the details necessary for the determination of fossil bones.

The object which I proposed to attain in these new researches on the osteology of fish, was, above all, to become acquainted with the forms of the head and of the cranium, to determine their ridges, the hollows, and the relief in all their details, and to find in these different forms general types of the family, of the genus, and of the species. If my predecessors have fixed on a regular type, the Carp or Perch, in describing their osteology, and in pointing out how these types may vary in the irregular genera, I, on the contrary, have had to direct my attention principally to closely-allied types, to search for the minute deviations which might accompany specific differences, to study the general character of the genus, to indicate the variations which the still more general type of the family might be subject, and thus to arrive at the possibility of distinguishing families, genera, and species by the osteology of the cranium. It will be conceived that this study is almost interminable; for—and this is a new manifestation of the infinite variety of nature—each genus, each family has its characteristic features, and its specific variations occur within fixed limits. In one family the absence of a central crest of the cranium may constitute a characteristic feature common to the whole family, while in another this crest will form but a generic or specific character, and so on. To arrive at an exact and minute knowledge of the laws which determine all the variations that may occur in the species, genera, and families, it will be necessary to possess the crania of all fish hitherto known. Let us hope that some day we shall arrive at this point; at present we are still far distant from it.

To give a sketch of the manner in which the osteology of fish must be treated for the purpose of throwing light on the investigation of fossil fish, and, in particular, on those of Sheppey, I shall indicate, in a few words, the characteristic features of the principal families, representatives of which have been met with in the London clay. If I pass over in silence the other families, it is not that I have neglected them; but, not wishing to extend this report to too great a length, I shall confine myself exclusively to those which have representatives among the fossils of Sheppey.

(To be concluded in our next Number.)

An Account of Electrical Experiments. By Mr R. ADIE, Liverpool. Communicated by the Author.

In the 75th Number of this Journal, I gave the details of some experiments which were designed to prove water batteries, to sustain their action by absorbing oxygen from the air. The present experiments are submitted as a continuation of the former, in order to determine the limits of the oxygen absorbing galvanic couples, and shew where they pass into those that disunite the elements of water, and act independent of the atmosphere; also to shew that in an oxygen absorbing couple, the gas is taken up around the negative plate. And to prove that the sectional area of the fluid in the cell of a battery governs the quantity of electricity lost through the resistance to conduction of the electrical current in passing from plate to plate; so that, where the wet materials of the earth form the battery cell, its infinitely great sectional area, render changes of distance betwixt the plates incapable of effecting the quantity of electricity conducted.

A zinc and platina couple, connected in the usual manner with the galvanometer, was immersed in ordinary fresh water, some distance below the surface. When the water was brought to boil, the indication fell gradually from 50°, until it reached within 5° of zero; on adding cold water containing air, there was a great rise in the action. The fact shewn by this experiment of ebullition destroying the action of the couple, appears to me to be at once conclusive of its requiring oxygen from the atmosphere; for by boiling all the absorbed air is expelled. When a little pure salt was added to the water, then the arrangement became quite independent of air, and even at 50° temperature, hydrogen was seen to rise slowly from the platina surface. Other metals platinized had the same action; but when the platina was replaced by pure gold or palladium then at temperatures of the weather, the oxygen of the atmosphere became requisite for their action. In my former communication above referred to, I stated that I found a zinc and silver couple to lose their effect under an exhausted air-pump receiver, whether they were excited by pure or by salt water. At temperatures of the weather this is strictly correct; but when the test of boiling the salt water was applied, then zinc and silver couples proved to be independent of the oxygen of the atmosphere; the galvanometer indication rose from 50° to 85°, where it remained so long as the boiling continued. Copper in lieu of silver gave results differing merely in degree; only it is worthy of remark, that the action of a zinc and copper couple in boiling sea water is not so great as in cold sea water holding absorbed air. These results clearly enough shew where the change from atmosphere supported galvanic action passes into one where water is decomposed. In boiling distilled water, or water from the new red sandstone formation, platina and zinc do not act. In salt water at ordinary temperatures, they are independent of the atmosphere. In cold salt water, copper, silver, gold or palladium, require air for the support of their action; while in boiling salt water their character changes, and a couple of zinc and copper can slowly act, while silver and less oxidizable metals act rapidly without need of oxygen from the air.

To ascertain where the oxygen was absorbed in the water battery, two tubes filled with oxygen were inverted over the upper portions of a zinc and platina couple excited by water; the connection betwixt the plates was contrived so that it could be made at pleasure, without disturbing the gas tubes. With a broken circuit there was no absorption of oxygen in the tube over the platina plate. When the circuit betwixt the plates was completed, the rate of absorption in the tube containing the zinc decreased a little, while beside the platina plate the rate of absorption now proceeded rapidly, being, when compared with that in the zinc, as 5 to 2. These experiments were for three days each, and similar results were afterwards obtained, where a piece of gas coke and a plate of copper were each substituted for the platina. The rate of 5 to 2 decreases when the zinc surface becomes partially oxidized, from the greater activity of local action, to which the whole of the absorption of oxygen beside the zinc plate is due. Amalgamating with mercury did not reduce the local action. Where the zinc remains for days untouched, the mercury lodges at the lower extremity, and thus an active couple is formed. Copper and platina plates under tubes of oxygen gave like results with much slower rates of action.

A piece of zinc was next cut into two halves, and connected in the usual manner with a long wire galvanometer, the helix containing 2000 convolutions. The two plates of zinc were immersed in water, and arranged to allow a tube containing oxygen to be placed at pleasure over the upper portion of either plate. After completing the connections, a short time was allowed for the galvanometer to reach zero; the tube filled with oxygen was then inverted over one of the plates which immediately deflected the galvanometer, shewing the *oxygenated zinc to be the negative element of the couple.* The tube was now passed over from the negative zinc to the positive piece, when, in the course of a few minutes, the galvanometer again shewed the new oxygenated zinc to be acting the part of a negative or platinode plate. The deflections of the needles were from 15° to 20°, where they remained steadily for some time. Instead of placing a tube of oxygen over one of the plates, if the water in front of one be stirred carefully with a quill, or if the plate be attached to an elastic wire, and made to vibrate in the water, it is immediately oxygenated more rapidly than the opposite one, and becomes strongly negative. The vibrated plate forms a very beautiful experiment. Like results were obtained with two pieces of iron. These experiments can all be readily explained, by referring to the gas battery of Professor Grove, where, in every step the action corresponds to the water battery, all the oxygen in the gas battery is taken up on the negative side, and oxygen placed in the tube beside the hydrogen, developes local action; so also in the water battery, oxygen supplied to the positive plate impedes the action,—a result which at first sight seemed to me very unexpected.

In considering the action of oxygen absorbing batteries, I have often felt a difficulty to satisfy myself what was the electrolite decomposed by the galvanic current in its passage from plate to plate. The received opinion is, that water is decomposed. A friend of mine, to whose views I attach value, on considering the results given above, came to the conclusion, that in the action of these couples, water was composed by the negative plate, at the same instant that an atom of oxygen combines with the metal or hydrogen of the positive plate. For my part, I can see no adequate force in couples of two pieces of zinc, or two pieces of iron to effect the union or disunion of the elements of water. The peroxide of hydrogen, a very much more easily decomposed body than water, according to Dr Turner's Chemistry, 7th edition, page 201, is not decomposed by iron;

but two plates of iron form a water battery, when one is exposed to more absorbed oxygen than the other; from which we should conclude that the electrolite of the gas or water battery, is a compound more easily decomposed than the peroxide of hydrogen. Evidence has been given to shew that water does not act until it contains dissolved oxygen. The whole question, then, rests on the state in which this gas exists in the water: if chemically combined with it, so as to form the solution of a sesquioxide of hydrogen, or some other more easily decomposed oxide than the peroxide, then, in air absorbing couples there exists a binary compound capable of obeying all the laws of electrolysis proved by Dr Faraday for acidulated water, where the water undergoes decomposition; while, in the gas battery, the action of the two plates is to decompose an oxide of hydrogen into water and oxygen, the nascent oxygen uniting with a metal or hydrogen at the positive plate.

The properties of the peroxide of hydrogen, as described in Dr Turner's Chemistry, appeared to me to be very much the same as those possessed by the solution of oxygen in water; and as the oxide of silver freely decomposes the former body, I wished to try its effect on the latter.

When a little oxide of silver is thrown into water, gas bells are slowly disengaged, and it changes from brown to a pale lilac colour. Two pieces of silver foil were placed in a horizontal position in water, and attached to a galvanometer. When a little of the oxide of silver was strewed on one of these plates, this converted it into a negative plate, and the bright piece of silver became positive. The current generated from a single pair deposited metallic copper from the sulphate. The change in colour of the oxide proceeds slowly, as before, and both plates were oxidized; the negative one, of course, through local action. An oxidized piece of silver acts as a negative, like the plate on which oxide of silver was strewed.

I have often been baffled while trying the effect of the rays of the sun on the action of oxygen absorbing couples, chiefly, I think, through the up-rising currents of water produced by the sun's rays. With the above arrangement of silver and its oxide I had no difficulty in obtaining the following effects: when the rays were allowed to fall on the positive plate only, the indication in the galvanometer rose; when they fell on the negative plate covered with the oxide of silver, and the positive side screened, the indication declined; when both plates of equal size were exposed to the solar rays, there was no decided change.

The following experiments on the effect of the changes of the sectional area of the exciting fluid in a galvanic couple, had their origin in some trials I made of the remarkable power of the earth for conducting electricity, as shewn by Professors Mattuecci and Belli's published results. See Phil. Mag. No. clxix, p. 540, where an electrical current is stated to have been passed through nearly 9 miles of earth with a very trifling loss. These results establish the fact that the wet soil is by much the most perfect electrical conductor known; and as this is very far from being the case when wet earth or water is tested in masses of definite section, I suspected that it was the change in the sectional area of the conducting medium which produced the effect noted; and it was to test this view that the following experiments were made.

I provided a small galvanometer which could be used with facility on the sea beach. At first I used a wire 300 yards long, but as I found the effects disturbed by the wire getting wet, and thus forming one of the plates of the couple, I preferred to use short wires, well coated with shell lac, and kept quite dry. Two wires of 6 yards each were connected with the galvanometer, and attached, one to a slip of zinc, the other to a slip of copper; these formed a galvanic couple capable of being adjusted with the utmost facility, with the plates 12 yards apart, down to near contact.

The galvanometer, screwed to a wooden spear, was fixed in a meadow on the bank of a clear slow-running stream. When the plates were thrust into the moist soil, as near together as they could be put without touching, the indication was 12°, from which it did not change on increasing the distance betwixt the plates to 12 yards. When the pieces of zinc and copper were removed to the clear water of the stream, the galvanometer rose to 38°, and kept its place steadily without reference to the distance the electricity had to pass through the water. The galvanometer was next carried to the sea beach, and placed among some rough stones by the edge of a pool of sea water. On thrusting the plates of the couple betwixt the stones into the interstices which were filled with wet sand the deflection was 40°; and by varying the distances of the plates from near contact to 12 yards there was no change. Like results were obtained in fine sand and in pools of sea water. In making these experiments the galvanometer cannot alway be got to the same point exactly, but by careful repetitions, I satisfied myself that the distances betwixt the plates had no connection with the variations noticed. The low deflection obtained in the moist earth is due to the small quantity of water retained in the soil.

The galvanometer, and its plates and wires, were carried home to be excited by water in an earthenware vessel; depth of water 1½ inches. The plates, when near in contact, indicated 30°; on gradually increasing their distance, the galvanometer indication fell, until it stood at 10°, with an interval of 15 inches betwixt the plates. Here, from a change of distance of only 15 inches, there is a loss of more than two-thirds of the electricity; while the same apparatus excited by water, resting, in connection with the wet materials of the earth, shewed no loss of electricity when the distance of the plates was increased 20 times as much. The depth of the water in the earthenware vessel was next increased to 9½ inches, when it was found that the loss of electricity from a distance of 15 inches betwixt the plates was only one half; and to produce the loss experienced when the water was 1½ inches deep, it was necessary to separate the plates 19 inches asunder.

A pair of zinc and copper plates were attached to a bar of wood 14½ inches long, and connected with a galvanometer less delicate than the one last used, but well calculated for observing small deviations. The piece of wood was suspended with counterpoises, so that it could be made to follow changes in the height of the surface of water contained in an earthenware vessel, without interfering with the galvanometer. With this arrangement the distance betwixt the plates was constant, and the sectional area of the exciting fluid increased with the depth of the water. The following are the indications noted by the galvanometer:—

Plates apart.	Depth of water.	Deflection.	Plates apart.	Depth of water.	Deflection.
14½ inches.	1½ inches.	6° 30′	8½ inches.	1½ inches.	5° 30′
...	5¼ ...	9° 10′	...	9½ ...	10°
...	9½ ...	9° 50′	...	19 ...	12°

Like results were obtained where both the distance betwixt the plates and the depth of water was stationary, with the diameter of the vessel varying. They all shew that the sectional area of the exciting fluid governs the quantity of electricity lost in passing betwixt the plates; and that, with the wet materials of the earth for a battery-cell, changes in distance betwixt the plates produce no perceptible alteration on their action.

The above experiments with the water-battery, which would now be more correctly designated by the term oxygen-absorbing-battery, will, I expect, conclude my examination of it. The subject has not that direct application to useful purposes which is always so certain to insure attention; nevertheless, should the experiments submitted tend to shew the nature of one of the most universal agents for producing chemical actions among the varied materials on the surface of the earth, their use to those engaged in the study of organic chemistry may ultimately prove them to be worthy of the expenditure of time they have required.

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On the Discovery of the Fossil Remains of Bidental and other Reptiles in South Africa. By ANDREW GEDDES BAIN, Esq., Surveyor of Military Roads under the Corps of Royal Engineers.

The district in which these fossils were found, is on the eastern frontier of the Cape Colony in South Africa, about 500 miles east of Cape Town. No granite has been observed here, and the lowest rocks are stratified, and in consequence of the dip, though variable, tending on the whole towards the interior of the country, the lower members of them are those nearest the coast.

A red quartzose crystalline sandstone is described by the author as the fundamental rock, and as alternating with a talcose slate. This sandstone is assumed to be of the carboniferous period, vegetable impressions, apparently of a Lepidodendron, having been found in it, and it is traced by the author towards the west, parallel to the coast, to within 50 miles of the Cape.

Over this there occurs a rock, called by the author a claystone porphyry, containing fragments of the sandstone; next an argillaceous slate, alternating with sandstone and containing thin laminæ of limestone, and at a little distance is a stratum full of vegetable remains.

Further to the north is a ferruginous sandstone with argillo-calcareous nodules, in which nodules were found the remains of reptiles characterised by the author as *Bidental*, and described by Professor Owen in the subsequent memoir. From the basin of Fort Beaufort to near the southern foot of the Winterberg range (which is about 90 miles inland) the same beds appear to be continuous, but they are interstratified with beds of greenstone which also occasionally intersect them.

The Winterberg peak (between 5000 and 6000 feet high) is a flat tabular mass of basalt. Several hundred miles to the westward of the peak a region extends of horizontal sandstone capped on the eminences by basalt, and intersected by numerous basaltic dykes. A similar region extends to the north of the peak. Here, again, reptilian fossils have been discovered, and they have also been brought from the country far to the north beyond the Orange River. Ammonites have been found at the summit of the Compass-berg, 150 miles NW. of the Winterberg.

The author does not venture to decide on the geological age of the formations he thus describes, but proceeds in conclusion to allude to some overlying deposits found near the southern coast of Albany, one of which is a red sandstone conglomerate, entirely without fossils, and resting unconformably on the supposed carboniferous sandstone; others are distinctly tertiary, and abound in shells resembling those of animals still living on the South African coast. A thick diluvial deposit is found near Fort Beaufort, and from the plains far to the northward beyond the Orange River, the fossil skull of a kind of buffalo has been obtained.

Description of certain Fossil Crania, discovered by A. G. BAIN, Esq., *in Sandstone Rocks at the South-eastern Extremity of Africa, referable to different Species of an extinct Genus of Reptilia* (DICYNODON), *and indicative of a new Tribe or Sub-order of Sauria.* By RICHARD OWEN, Esq., F.R.S., F.G.S., &c.

The most remarkable character in these fossils, is the presence of two long curved and sharp-pointed tusks, which, like those of the Walrus, descend one from each superior maxillary bone, and pass on the outside of the fore part of the lower jaw, a character rare even in Mammals, and hitherto only met with in that class; but in these specimens combined with a structure of the cranium, proving that the animals belonged to the class Reptilia, but were members neither of the Crocodilian nor Chelonian orders. The Lacertine Sauria offer characters for comparison, but the minor deviations from the ordinary Lacertian structure are so numerous, the mode in which Crocodilian and Chelonian characters are interwoven upon an essentially Lacertian base is so interesting, and the individual and distinctive characters of the Dicynodons so striking and peculiar, as to require a detailed osteological description for their complete illustration.

In these animals, the Crocodilian structure is chiefly manifested in the occipital region of the skull, and gives place to the Lacertian characters in the upper and fore part; but in regard to these deviations it must be remembered, that the distinctive features of the Crocodilian type are most broadly manifested in the existing representatives of the order, and are modified and rendered less salient in the more numerous and varied extinct members.

It is necessary to bear in mind this tendency to the amalgamation of Crocodilian and Lacertian characters in the older Loricata, in order to form a right estimate of the value of those correspondences with the cranial peculiarities of the existing Lacertians.

Nevertheless, various characters justify the conclusion, that the general type of cranial organisation manifested by modern lizards, was that in which the peculiar modifications of the Dicynodon have been superinduced. It is not, however, amongst the modern lizards that we find the nearest approximation to the Dicynodon. For this we must go as far back into the period of Reptilian life on this planet as the epoch of the new red sandstone, when the *Rhynchosaurus* manifested the Lacertian type of skull, combined with toothless jaws, which were most probably sheathed with horn. What concerns us most in the present inquiry, is the anomalous edentulous sharp edge of the upper and lower jaws in the ancient Rhynchosaur, and the Chelonian form of the deep lower jaw, the same anomaly having been repeated in the extinct African lizard, of apparently as remote a period, with the superaddition of Mammalian canine tusks. For the rest, much difference of form is manifested in the two extinct genera; but it is interesting to remark the same peculiar contraction of the cranial cavity, indicating an arrested development of brain in both of them. The dental peculiarity of the African Saurian forms its chief distinction from the Rhynchosaurus, as from all other Sauria: but with the strange superaddition of its two canine tusks, we must bear in mind that the affinities linking the Dicynodon to Crocodilians and Chelonians are much more strongly manifested than they are in the Rhynchosaurus.

The author, in concluding his account of the Dicynodon, adverts to the analogy of structure, which radiates from this genus in the direction of the Ophidian division of existing Reptilia, although it is unsupported by any other concordances of cranial or dental organisation than those about to be cited. In the poisonous serpents, the rattle-snakes for example, the intermaxillary bone is single and edentulous; the maxillary bone supports a long, curved, pointed tooth, which, when advanced, descends outside the lower jaw. Apart from all the other peculiarities of the maxillary and dental systems of the poison-snakes, they alone, of all existing Reptilia, repeat, in the above-cited structures, the characters of the Dicynodon. But, in addition to the two large maxillary teeth, the rattle-snake has smaller teeth in rows upon the palatine, pterygoid and mandibular bones. To complete the resemblance between the tusks of the Dicynodon and the venom fangs of the snake, you must deeply groove their fore-part, or bore a canal through their centre; you must remove those strong columns of bone which converge to, abut against, and strengthen the fixed socket of the tusk, and you must suspend the maxillary bone by a moveable pedicle to the prefrontal and malar bones. Besides, the perforated tusk of the poisonous serpent is always followed by one or more similar teeth, in various stages of growth, ready to supply its place, according to the general law of the maintenance in serviceable state of the dental armature of the jaws throughout the Reptilian class.

The canine tusk of the Dicynodon consists of a simple body of compact unvascular dentine, with a very thin outer coat of enamel, which may be traced into the alveolus for a short distance. Rather more than one-third of the tusk is lodged in the socket, the basal conical pulp-cavity is continued from the base about one-half down the implanted part of the tusk, and a linear continuation extends along the centre of the rest of the tusk, from which the dentinal tubes of the solid body of the tusk radiate. They present gentle parallel secondary curves or undulations throughout their course, divide dichotomously twice or thrice near their beginnings, and send off numerous small lateral branches, chiefly, but not exclusively, from the side next the apex.

The principal difference in the microscopic texture of the tusks of the Dicynodon, as compared with the teeth of the crocodile, consists in the closer and more compact arrangement of the calcigerous tubes of the dentine; by which character it makes a closer approach to the intimate texture of that tissue in the canine teeth of the carnivorous Mammalia.

In the other Reptilia, recent or extinct, which most nearly approach the Mammalia in the structure of their teeth, the difference characteristic of the inferior and cold-blooded class is manifested in the shape, and in the system of shedding and succession of the teeth. The dental armature of the jaws is kept in serviceable order by uninterrupted change and succession; but the matrix of the individual tooth is soon exhausted, and the life of the tooth itself may be said to be comparatively short. Evidence of this low organised dental condition, common to fishes, has been obtained in every reptile, in which the implanted base of the teeth has been examined by the author.

The existing Lacertians superadd to this endless shedding and succession of teeth, the ichthyic character of anchylosis of the base of the teeth in use to the osseous substance of the jaw; so that in the *Rhynchocephalus* and other acrodont lizards, the teeth appear like small enamelled processes of the alveolar border. The Dicynodons not only manifest the higher type of free implantation of the base of the tooth in a deep and complete socket, common to Crocodilians, Megalosaurs, and Thecodonts, but make an additional and much more important step towards the Mammalian type of dentition by maintaining the serviceable state of the tusk by virtue of constant renovation of the substance of one and the same matrix, according to the principle manifested in the long-lived and ever-growing tusks and scalpriform incisors of the Mammalia. This endowment of the teeth of a reptile is far more remarkable and unexpected than the more obvious character of the size and shape of the long exserted tusks themselves, superadded as they are, and in such strange combination, with the otherwise edentulous jaws of a bird or turtle. Yet if we consider the fact in its relations to the exigencies and convenience of the living animal, the wisdom and beneficence of the principle is apparent, and the departure from the ordinary rule manifests a power transcending the trammels of scientific system. The teeth of the Dicynodon being but two in number, and their use to the animal indicated by their unusual size to be of unusual importance, the inconvenience and detriment that must have ensued from frequent shedding and replacement is very obvious; we may readily conceive it to have been incompatible with their functions, and therefore abrogated in favour of another mode of renovation which is abnormal in reptiles, simply, perhaps, because the form, proportions, and function of such tusks were unique, and are now no longer manifested in a cold-blooded class.

Some observations may be naturally expected in reference to the probable use of the tusks to the Dicynodons, and the mode of life of those ancient and most remarkable saurians. In the Mammalian class, where alone we now find the analogous instruments, tusks are usually given as weapons of offence and defence,—an office exemplified in the hornless musk-deer, the boar, and in the large canine teeth of the Carnivora. The elephants use their tusks chiefly, though not exclusively, as lethal weapons: the Walrus is said to apply his tusks to aid in clambering over icebergs, as well as in combat and defence: the Dugong is supposed to wear the exserted points of the tusks in detaching fuci for food. Such an office at first suggests itself as a very probable one in regard to tusks descending, like those of the Dugong, from the upper jaw, and combined with edentulous and probably horny mandibles like those of a fucivorous turtle.

On inspecting the remains and the impressions of the tusks in the fossils under consideration, and especially in the almost entire skull of one species, the *Dicynodon lacerticeps*, we perceive that these weapons are sharp-pointed, and present no trace of that obliquely bevelled or chisel-shaped extremity which is produced by habitual application in acts of obtaining daily food, as, for example, in the protruded extremities of the tusks of the Dugong and the incisors of the Rodents. The tusks of the Dicynodon, though similar, in their origin from maxillary bones and downward direction, to the tusks of the Walrus, are so much shorter, at least in the single specimen in which their entire length is shewn, that they could not be available in locomotion. I conclude, therefore, from their shape, proportional length, sharp points, and dense texture, that the tusks of the Dicynodon were applied by the living animal either for the purpose of killing its prey, or of defending itself from its foes, or in both acts; and that they are offensive and defensive arms.

A further insight into the habits and mode of life of the Dicynodons may reasonably be expected to follow the examination of the skeleton of the trunk and the organs of locomotion. This will form the subject of a subsequent memoir; but the vertebræ of the Dicynodon present the sub-biconcave structure common to most of the older extinct saurians, which structure, in comparison with the ball and socket vertebræ of the modern species, indicates a more aquatic and perhaps marine theatre of life for the amphibia which swarmed in such plenitude of development and diversity of forms during the ancient secondary periods of the geologieal history of this planet.—*Proceedings of the Geological Society*—vide *Transactions of the Geological Society for Messrs Bain and Owen's Memoirs in full.*

On the Luminousness of the Earth. By BARON VON HUMBOLDT.

If the luminous phenomenon which we ascribe to a galvanic current, *i. e.*, a movement of electricity in a circuit returning into itself, be designated by the indefinite name of the Northern light, or the Polar light, nothing more is thereby implied than the local direction in which the beginning of a certain luminous phenomenon is most generally, but by no means invariably, seen. What gives this phenomenon its greatest importance, is the fact which it reveals, viz., that *the earth is luminous;* that our planet, besides the light which it receives from the central body, the sun, shews itself capable of a proper luminous act or process. The intensity of the earth-light, or rather the degree of luminosity which it diffuses, exceeds by a little, in the case of the brightest coloured rays that shoot up to the zenith, the light of the moon in her first quarter. Occasionally, as on the 7th of January 1831, a printed page can be read without straining the sight. This light-process of the earth, which the Polar regions exhibit almost incessantly, leads us by analogy to the remarkable phenomenon which the planet Venus presents. The portion of this planet which is not illuminated by the sun, glows occasionally with a proper phosphorescent gleam. It is not improbable that the moon, Jupiter, and comets, besides the reflected sun-light recognisable by the polariscope, also emit light produced by themselves. Without insisting on the problematical, but very common phenomenon of *sheet-lightning*, in which the whole of a deep massy cloud is flickeringly illuminated for several minutes at a time, we find other examples of terrestrial evolutions of light. To this head belong the celebrated *dry-fogs* of 1783 and 1831, which were luminous by night; the steady luminousness of large clouds, perfectly free from all flickering, observed by Rozier and Beccaria; and even the pale diffused light, as Arago has well observed, which serves to guide us in the open air, in thickly clouded autumn and wintry nights, when there is neither moon nor star in the firmament, nor snow upon the ground. As in the phenomenon of the Polar light occurring in high northern latitudes, in other words, in electro-magnetic storms, floods of flickering, and often party-coloured light stream through the air; so in the hotter zones of the earth, between the tropics, are there many thousand square miles of ocean which are similarly light-engendering. Here, however, the magic of the light belongs to the organic forces of nature. Light-foaming flashes the bursting wave, the wide level glows with lustrous sparks, and every spark is the vital motion of an invisible animal world. So manifold is the source of terrestrial light. And shall we conceive it latent, not yet set free in vapours, as a means of explaining Moser's *pictures*,—a discovery in which reality still presents itself to us as a vision shrouded in mystery?—*Kosmos*, s. 206, and *Cosmos*, English edition, p. 209.

On the Rocks said to be older than the oldest Fossiliferous Deposits.

Mr Lyell, in his Travels in North America, states, in the following terms, his opinion as to the non-existence of Primitive Rocks.

As it is still a favourite theory of many geologists, that the granite and other formations, both stratified and unstratified, which I have called hypogene, were produced in far greater abundance before the origin of the oldest strata at present known to contain fossils than at any subsequent period; and as some are disposed to consider their conclusions on this head much strengthened by the fact that, in North America, as in Europe, there are certain points where granite, mica-slate, and gneiss, can be shewn to be of prior date to any of the fossiliferous rocks hitherto detected,—I shall briefly refer to the leading arguments against this doctrine, which I have advanced both in my "Principles" and "Elements of Geology."

The crystalline formations, such as granite and gneiss, were termed primitive and primary by some of the earlier observers, because in each district they are the lowest in geological position. It is now understood, in regard to granite, syenite, and the unstratified class, that they are of various ages, often newer than fossiliferous strata; and that it by no means follows that they were first in the order of time, because they are inferior in position. Paradoxical as the first statement of this proposition appears, it is now acknowledged that the superstructure is often older than the foundation on which it rests, the latter having been forced up subsequently from below, either in a solid form, or, more frequently, like lava in a volcano. It is also now admitted, in direct contradiction to all preconceived opinions, that many stratified hypogene formations, the gneiss, mica-slate, talc-slate, and saccharine marble of the Alps, Apennines, and other districts, have assumed their crystalline texture after the origin of many of the fossiliferous strata; even in some cases long after the deposition of those which repose directly upon them.

Nevertheless, if we confine the term primary to all rocks which we can prove to be of older date than strata in which organic remains have yet been discovered, we may affirm that the gneiss of Kinnekulle in Sweden before alluded to, or of the falls of Montmorenci, and many of the unstratified or Plutonic rocks of the Adirondack Mountains, west of Lake Champlain, are truly primary. We may also extend the same appellation, without much liability of error, to all the crystalline rocks found for a considerable space on every side of the points where the lowest strata charged with fossils are incumbent upon the non-fossiliferous formations. But the farther we go from such points of departure, the more unsafe does our generalization become; and the American geologists have already found reason to retract their first conclusion, that the gneissose, micaceous and talcose schists, of the Taconic range (see above, p. 245, vol. i.), are referable to a *primary* series.

The posteriority of age of many masses of granite and other Plutonic rocks, is more easily proved than the modern origin of the stratified hypogene formations, because the former produce alterations of moderate extent, at the point of contact, or send veins into the newer fossiliferous strata. But where these strata have been altered on a great scale in texture, by heat and other subterranean causes, the evidence of transmutation is difficult to detect, in proportion to the intensity of the metamorphic action. The study of the Alps and Apennines has shewn, that it is characteristic of such action to annihilate all signs of the date of its development, by the obliteration throughout entire mountain masses of all traces of organic structure. We are therefore entitled, on every principle of sound reasoning, to suspect, that for one case where we can positively establish the secondary origin of any set of crystalline strata, there are many others where the proofs of their modern origin have been destroyed.

A geologist, whose observations had been confined to Switzerland, might imagine that the coal measures were the most ancient of the fossiliferous series. When he extended his investigations to Scotland, he might modify his views so far as to suppose that the old red sandstone marked the beginning of the rocks charged with organic remains. He might, indeed, after a search of many years, admit that here and there some few and faint traces of fossils had been found, in still older slates, in Scotland; but he might naturally conclude that all pre-existing fossiliferous formations must be very insignificant, since no pebbles containing organic remains have yet been detected in the conglomerates of the old red sandstone. Great would be the surprise of such a theorist, when he learnt that in other parts of Europe, and still more remarkably in North America, a great succession of antecedent sets of strata had been discovered, capable, according to some of the ablest palæontologists, of constituting no less than three independent groups, which are each of them as important as the "old red" or Devonian system, and as distinguishable from each other by their organic remains. Yet it would be consistent with methods of generalizing not uncommon on such subjects, if he still took for granted, that, in the lowest of these "Transition" or Silurian rocks, he had at length arrived at the much-wished-for termination of the fossiliferous series, and that Nature had begun her work precisely at the point where his retrospect happened to terminate.

It may be useful to inquire, whence arises this strong tendency to believe that the present limits of human knowledge in geological science exactly embraces that period of past time in which organic beings have flourished on the earth. If it be a very common delusion, there must be some cause for its popularity. Its source is, I believe, twofold; *first*, it is almost unavoidable that we should underrate the magnitude of the subterranean changes now in progress at great depths in the earth's crust; and, *secondly*, that we should equally exaggerate the amount of those which took place far below the surface at former eras, especially those most remote from our times.

In regard to the first of these sources of error, we have of late years grown familiar with the proofs of great subsidence and upheaval of land in modern times, without sufficiently reflecting on the enormous alterations in the condition, and probably the structure, of the subjacent parts of the earth's crust which are implied by these movements. The connection of such rising and sinking of the solid parts of the globe with volcanic action, can be demonstrated in many places, and fairly inferred in others, where the action of subterranean heat, owing to its great depth, is latent. I have endeavoured elsewhere to explain the grounds which we have for inferring that crystalline formations have been elaborated at many successive periods, both secondary, tertiary, and still more modern. We need go no farther, indeed, than the valley of the St Lawrence, now under consideration, to find wide areas covered with marine shells of *recent* species, at the height of 500 feet above the sea, and where all the rocks can be shewn both to have sunk and to have been again uplifted bodily, for a height and depth of many hundred feet, since the deposition of these shells.

But however firmly we may be convinced that subterranean causes, connected with the development of internal heat, have operated with great, and perhaps nearly uniform intensity, at each successive geological period of equal duration, we must still be prepared to find that by far the largest portions of the visible hypogene rocks are of high relative antiquity to the fossiliferous deposits. This must happen if we are correct in assuming that the crystalline rocks, whether stratified or unstratified, have been formed originally at considerable depths in the crust of the earth. For, in that case, a long period of time must have elapsed after their origin before they can have been brought up within the sphere of human observation. There must have been great upheaval and denudation to cause them to emerge, even in a single district; but it must require a series of geological epochs before those formed at a given era of the past, can have become generally exposed at the surface. A repetition of one series of elevatory movements after another must have taken place in different areas, accompanied by denudation; and while such forces are acting the deposition of new strata is going on, and the pre-existing crystalline rocks are becoming relatively more and more ancient.

What was before said, of the succession of ages required to raise deep new formations extensively to the surface (see p. 55), is equally applicable to rocks of deep subterranean origin. Hence it follows that the high relative antiquity of the visible crystalline rocks afford no better a presumption in favour of a period when nothing but granite and gneiss were formed, than the pelagic character of the visible silurian strata and the absence of contemporaneous littoral deposits, simply the universality of the ancient ocean.—*Travels in North America*, vol. ii. p. 128.

Synopsis of the Fall of Rain in the Lake District of Cumberland, for Twelve Months, commencing the 1st day of July 1844, and ending the 30th day of June 1845.

The Gauges are all of the same size and shape, and the meters were all obtained from Mr Bate, of the Poultry, London.

MONTHS.	Whitehaven.	WET DAYS.	Cockermouth.	WET DAYS.	Keswick.*	WET DAYS.	Ennerdale Lake, Bowness.	Stonywath, 2 miles from the Lake.	WET DAYS.	Loweswater Parsonage.	WET DAYS.	Buttermere.	WET DAYS.	Gatesgarth.	WET DAYS.	Grasmere.*	WET DAYS.	Wasdale Head.	WET DAYS.	Seathwaite, Borrowdale.	WET DAYS.
1844.																					
July	4.183	14			3.052	17	5.549	4.151	11	3.425	16	4.59	17	5.70	16	4.874	17	6.36	12		
August,	1.999	14			5.727	18	4.863	4.164	16	5.564	15	7.55	20	9.08	21	6.856	17	10.74	16		
September	5.809	11			4.780	11	6.327	5.417	7	6.185	9	6.33	11	7.92	12	5.381	12	9.23	8		
October	4.335	21	4.760	20	5.272	21	6.240	4.493	17	7.121	19	8.22	21	10.78	23	8.644	15	9.45	18		
November	1.926	13	2.607	15	2.842	12	3.700	2.151	10	3.048	11	3,69	11	5.49	16	6.397	12	5.26	15		
December	.309	6	.200	6	.108	5	.790	.170	3	.307	5	.33	3	.47	5	.845	4	.47	2	.57	4
1845.																					
January	4.541	21	3.195	19	6.434	21	7.560	5.095	19	7.100	21	9.53	21	13.78	21	15.023	22	11.00	20	16.81	22
February	2.880	10	1.045	6	1.004	9	2.160	1.825	6	1.897	8	1.70	8	2.61	11	2.252	9	3.40	9	3.48	11
March	3.735	14	3.895	14	3.978	14	6.715	4.532	12	5.814	14	7.06	12	9.07	15	10.256	15	10.37	13	13.21	15
April	2.587	13	2.330	11	4.886	12	5.500	2.960	11	4.859	12	7.31	11	10.60	12	6.133	12	7.40	12	10.57	11
May	1.480	17	1.970	16	2.270	15	3.200	2.200	15	2.629	15	3.62	17	4.90	16	2.289	12	4.13	14	4.57	15
June	4.099	16	3.090	18	4.032	17	5.550	4.305	17	4.954	15	5.97	16	8.02	17	5.010	16	6.15	16	8.25	18
TOTALS	37.833	170	23.092	125	44.385	172	58.154	41.463	144	52.903	160	65.90	168	88.42	185	73,960	163	83.96	155	57.46	96
From October	25.842	131																		From Dec. 1844	

* The results from Keswick and Grasmere are inserted by permission of the respective registrars.

At Gatesgarth, there have been 16 days wherein the fall was between 1 and 2 inches, 8 days on which it was between 2 and 3 inches, and 2 days on which it *exceeded* 3 inches.
At Wasdale, there have been 15 days of the first, 6 days of the second, and 2 days of the third class.

Through the kindness of various Gentlemen, we are enabled to add returns from a few other places, by way of comparison.

FALL FROM JULY 1844, TO JUNE 1845, INCLUSIVE.

	Rain.	*Wet Days.*		*Rain.*	*Wet Days.*
Easthwaite Lodge, Lancashire,	58.932		Liverpool,	26.280	191
The Oaks, Ambleside,			Manchester,	26.50	
Kendal,			North Shields,	19.707	188
Cleator, near Whitehaven,	40.020	181	York,	21.450	158
Harraby, Carlisle,	26.092	200			

The fall of rain at York in the month of January was .87, or rather more than 3-4ths of an inch, whilst the quantity measured at Seathwaite was nearly 17 inches, or 20 times as much.

REMARKS ON THE FOREGOING TABLE.

When it is borne in mind, that the period comprehending the above results has been one of the driest on record, we must admit, that the quantity of rain annually deposited in the Lake and mountain district is indeed great, beyond all anticipation. An inspection of a map of the county, in connection with the table, will shew that the three wettest portions of the Lake district (Seathwaite, Gatesgarth, and Wasdale), are those situate at the extremities of our highest mountain ridges, amongst which are Great Gavel, Sca Fell, High Stile, Red Pike, and Honister, the former being apparently the grand central point which attracts and condenses the warm vapour arriving in a south-westerly direction across the Atlantic; and it is also a remarkable coincidence, that most of our lakes, both large and small, bear in the direction of Gavel, so that, if extended onward in a direct line, they would all converge at the base of this noble mountain.

Prior to the establishment of these gauges, the vale of Grasmere, in Westmoreland, was considered to be the wettest locality in Great Britain. But here we find that, in twelve months, Grasmere has been exceeded at Gatesgarth by 14.460 inches, or one-fifth, and at Wasdale by 10.00 inches, or one-seventh nearly.

Yet immense as is the deposit of rain at Gatesgarth, Wasdale, and in other portions of the district, even these enormous quantities sink into comparative insignificance, when compared with the fall at Seathwaite, a small hamlet at the head of the vale of Borrowdale. From the 1st January to the 30th June, in the present year, a period marked by a deficient supply of moisture, the fall at Seathwaite is no less than 56.97 inches, being 8 inches, or one-fifth, more than at Gatesgarth, and 14½ inches, or one-third, more than at Wasdale, in six months only.

Now, it is chiefly the deposit in the vale of Borrowdale, and on the high range of mountains surrounding it, which supplies the majestic river Derwent, and the extensive and picturesque lakes of Derwent and Bassenthwaite, so that we might, *à priori*, have expected to find the greatest amount of rain in this portion of the district.

The great difference in the fall between Ennerdale Lake and Stoneywath, and between Loweswater, Buttermere, and Gatesgarth, each about two miles distant from the other, is worthy of notice. The current of vapour is apparently only partially decomposed in passing over a flat or even an undulating country, but on reaching the mountains, the sudden change of temperature causes a rapid condensation, in the form of vast torrents of rain, whilst comparatively little descends on the adjacent plains. That the rapid increment in the fall, in the mountainous districts, is owing to this cause, and not to the greater number of wet days, is evident, on an inspection of the table, where it will be found that we have fully as many wet days at Whitehaven, nearly level with the sea; indeed, it rarely rains in the Lake district, that the day is not also wet, more or less, at the coast. The utility and beauty of this arrangement is obvious, since the mountain torrents afford a continous supply of water to our lakes and rivers, which otherwise could scarcely have an existence.

J. F. MILLER.

WHITEHAVEN, *July* 18. 1845.

Observations on the Temperature and Moisture of the Atmosphere, and on the Temperature and Specific Gravity of the Surface Water of the Northern Atlantic. By ROBERT LAWSON, Assistant-Surgeon, 47th Regiment. Communicated by the Author.

The distribution of temperature in the sea and superincumbent atmosphere is very imperfectly known. Were a few only of those who annually cross the Atlantic, to bestow some little trouble on the subject, a mass of information would be rapidly accumulated regarding it, which would be of the greatest value. During a voyage from Gibraltar to Barbadoes in 1841, and from that island to England in 1842, I made a series of observations on these points. The results, which possess some features of interest, are given below.

The temperatures were observed by instruments, the errors of which were carefully ascertained (they are known everywhere to be about 0°·1 Fahr.), and have been allowed for in the tables. The dew-point is calculated, from the indications of a wet-bulb thermometer, by Dr Apjohn's tables, and, from some comparative experiments I made in the West Indies, may, I think, be depended upon to within a fraction of a degree.

The specific gravity of the water, taken during the voyage home, was determined soon after my arrival. The balance employed indicated distinctly $\frac{1}{50}$ of a grain, when loaded with 4000 grains. The water was weighed in a bottle which held about 1000 grains of distilled water, and every care was taken to ensure accuracy, by ascertaining the errors of the weights employed, and weighing the bottle in both pans of the balance. The specimens were weighed at temperatures within a few degrees of 62° Fahr., and the weights subsequently reduced to 62°, by data derived from observing the rate of expansion of sea-water above and below that point, the effect due to the expansion of the glass having been eliminated in all. The most troublesome point was to determine the temperature of the specific gravity bottle and its contents; and, as a difference of 0°·1 Fahr. throughout the mass corresponds with a unit in the fifth place of decimals in the specific gravity, it is clear that a slight error in the temperature would affect it sensibly: by placing the bottle, however, full of salt water, into a small vessel of water, and gently agitating both with thermometers, the moment their respective temperatures coincided was shewn, when the stopper was inserted, and the superfluous fluid wiped away. The greatest difference between the temperatures of the contained and surrounding fluids, did not, in any of the experiments, exceed 0°·2 Fahr.

TABLE I. *Thermometrical Observations, &c., on a Voyage from Gibraltar to Barbadoes, in March* 1841.

Date.	9 A.M.		3 P.M.		Wind.		At Noon.		
	Temp. of Air.	Dew Point.	Temp. of Air.	Dew Point.	9 A.M.	3 P.M.	Temp. of Sea-water.	Lat. N.	Long. W.
Mar. 8	62°.2	58°.3	63°.3	59°.4	E.	SSE.	60°.8	35° 27′	7° 58′
9	63.9	58.7	63.3	59.5	SE.	SE.	61.9	34 51	10 23
10	64.0	59.4	66.5	55.9	SE.	SSE.	61.5	33 26	12 9
11	66.9	57.1	64.5	59.1	SSE.	E.	64.2	32 38	13 35
12	66.2	61.6	65.9	62.2	SSE.	ESE.	65.2	31 50	15 30
13	62.7	58.5	64.5	59.8	SE.	ESE.	64.0	30 58	16 32
14	66.2	62.7	66.9	63.8	SSE.	SSW.	64.5	30 40	17 48
15	65.9	60.3	65.8	61.2	NW.	ENE.	65.8	29 43	18 40
16	64.4	55.7	64.7	55.5	NE.	ENE.	65.9	28 24	20 0
17	65.2	52.2	65.0	55.5	ENE.	NE.	65.5	27 21	22 24
18	66.2	56.7	66.9	58.3	NE.	NE.	68.5	25 25	24 56
19	68.1	57.9	67.9	60.5	NE.	NE.	70.2	23 25	27 22
20	70.0	53.2	70.6	61.6	NE.	NE.	70.8	22 18	29 28
21	70.3	62.3	70.3	61.3	NE.	ENE.	71.3	20 33	31 38
22	71.0	63.5	71.9	61.7	E.	ENE.	73.0	18 54	33 46
23	73.9	64.4	73.6	63.6	E.	ENE.	74.1	17 16	36 7
24	74.4	65.2	74.1	65.4	NE.	NE.	74.8	16 0	38 59
25	74.5	66.5	74.3	68.2	NE.	NE.	75.4	14 34	41 41
26	76.9	68.2	75.8	68.0	NE.	NE.	76.1	13 44	44 17
27	76.1	67.5	76.1	69.0	NE.	NE.	76.8	13 16	47 46
28	76.9	70.3	77.5	70.2	ENE.	ENE.	77.3	12 59	50 49
29	77.3	69.0	78.0	69.7	NE.	NE.	77.7	12 46	53 53
30	78.1	71.3	78.2	70.1	ENE.	NE.	78.1	13 11	56 45
31	78.9	71.7	...	...	E.	...	79.1	13 1	59 10

On the 10th March, a very heavy squall occurred, which, fortunately, only split a topsail and topgallant-sail. At 9 A.M. there was a very slight breeze from the SE.,* which died away towards noon; at this time it was densely overcast, and the clouds high. All round the southern horizon a sort of mirage appeared partially, running rapidly from one place to another and abruptly breaking its continuity thus, . The master of the ship informed me he had frequently seen a similar appearance off the Cape; but he did not seem aware of its nature. The same appearances continued until 1 P.M., when, the deck having been left in charge of a very inexperienced young man, the squall suddenly came on, from about SSE., with great violence, preceded only by a few small drops of rain. After the most violent part had passed, a hot parching gust of wind was experienced, which, in its turn, was immediately followed by a cooler breeze; and this alternation occurred several times. I observed the thermometer as high as 78°·7 in one of these gusts, and almost immediately after it fell to 70·8; but I feel certain that, during some of the first of them, the temperature must have been greater. Soon after this squall, the clouds broke, and the wind settled at SSE., but continued slightly squally, and with occasional hot puffs, all the afternoon. The fall of the dew-point from 9 A.M. to 3 P.M. is worthy of notice.

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* All the bearings are corrected for the variation of the compass.

On the morning of the 20th March, when about 700 miles from the nearest land, a hot breeze was again experienced, but to a less extent; while it lasted, the dew-point was very low, and a peculiarly parched sensation in the nose and throat was felt. Towards afternoon the parched sensation went off, and, as may be seen in the table, the dew-point rose considerably.

The trade-wind commenced on the evening of the 15th March. The dew-point fell considerably lower next morning than it had been for some days before with the south-easterly winds. The same combination of a high dew-point with SE. winds is noticed all over the Mediterranean, and also right across the Atlantic.

The variations in the temperature of the sea were nowhere very great. There was an increase of 2°.7 on the 11th, after which it fluctuated slightly until the 18th and 19th, on which it increased 3°·0 and 1°·7 respectively. A marked increase of temperature occurred also on the 22d and 23d, after which it went on gradually and regularly until the 31st, when, the ship having got into the equatorial current which sets along the coast of South America to the NW., it rose 1°·0 from the previous noon. During the month of April, while lying at Barbadoes, the temperature of the water in Carlisle Bay, half a mile off shore, and in 17 fathoms, was found, from the mean of five observations, to be 79°·3. On the 2d April, the surface water in the sun was 79°·3, while at the depth of 17 fathoms it was 78°·7. On the same day, with a fresh trade blowing, the surface water in the ship's shadow was found to be decidedly lower in temperature than that at the depth of 3 or 4 feet, evidently from the evaporation going on from it while within the shadow.

TABLE II. *Thermometrical Observations, &c., on Voyage from Barbadoes to England in February and March* 1842.

Date.	9 A.M.		3 P.M.		Winds.				At Noon.				
	Temp. of Air.	Dew Point.	Temp. of Air.	Dew Point.	9 A.M.	Force.	3 P.M.	Force.	Temp. of Sea-water.	Spec. Grav. of Sea-water at 62°.	Lat. N.	Long. W.	Drift of Current in previous 24 hours.
	°	°	°	°		*			°		° ′	° ′	
Feb. 12	...	...	76.1	69.1	...	...	ENE.	6	76.8	1.02801	17 41	60 18	N. 50° W. 8 miles.
13	76.6	66.0	75.3	66.7	ENE.	7	ENE.	6	76.8	1.02774	20 5	61 14	N. 68° W. 29 ...
14	74.5	63.2	74.0	64.0	E. by N.	5	E. by N.	3	76.1	1.02770	22 25	61 26	N. 34° E. 7 ...
15	74.5	64.6	73.6	64.9	E.	2	E.	2	75.4	1.02802	23 53	61 1	N. 14° E. 4 ...
16	73.3	65.0	73.6	64.1	E.	6	ESE.	5	74.3	1.02814	25 59	60 11	N. 63° W. 22 ...
17	72.1	67.5	71.0	67.2	SE. by E.	6	SE. by E.	6	70.8	1.02811	28 19	57 36	N. 15° W. 24 ...
18	70.9	67.0	69.9	66.5	ESE.	4	ESE.	4	69.8	1.02786	29 51	55 58	N. 55° W. 21 ...
19	68.8	65.0	68.3	63.5	E. by N.	3	E. by S.	3	68.5	1.02794	31 37	55 24	N. 29° E. 13 ...
20	68.8	62.8	68.5	61.0	SE. by S.	3	SW. by S.	...	67.8	1.02798	32 59	54 47	N. 68° W. 49 ...
21	66.3	60.0	67.1	61.9	S. by W.	...	SW. by S.	5	65.9	1.02782	34 14	51 53	N. 68° E. 43 ...
22	64.5	60.4	...	...	SW. by S.	5	...	...	65.0	1.02784	36 3	48 58	N. 41° E. 12 ...
23	64.5	61.2	65.0	60.0	SSW.	6	SW. by S.	6	63.8	1.02796	37 49	45 34	N. 84° E. 10 ...
24	65.0	60.2	65.0	62.0	S. by W.	6	SSW.	6	63.1	1.02770	39 25	41 40	S. 28° E. 2 ...
25	53.4	46.6	57.3	39.4	N. by E.	6	NNW.	2	62.3	1.02777	40 25	38 38	S. 34° E. 7 ...
26	54.2	44.9	50.8	40.8	NW. by W.	8	W. by N.	8	60.5	1.02781	41 38	34 57	S. 77° E. 27 ...
27	47.1	42.2	45.1	42.4	W.	6	N.	7	56.7	1.02729	42 40	31 34	N. 68° W. 6 ...
28	45.6	34.9	46.9	36.8	NW.	7	NW.	6	56.4	1.02758	43 41	28 49	S. 25° W. 21 ...
Mar. 1	53.2	40.0	55.2	49.4	SW. by S.	5	SSW.	7	54.3	1.02742	45 1	25 16	S. 45° E. 16 ...
2	56.5	50.1	56.2	49.1	SSW.	8	SSW.	9	53.0	1.02735	46 43	20 35	N. 61° E. 23 ...
3	48.1	42.3	50.4	37.0	NW. by W.	6	NW. by W.	4	52.0	1.02712	47 47	15 34	N. 82° E. 29 ...
4	48.6	34.4	48.6	35.8	NW. by W.	3	NW. by N.	3	51.2	1.02733	48 34	12 36	S. 18° W. 13 ...
5	50.4	36.1	48.2	32.3	S. by E.	1	E.	2	50.0	1.02742	48 59	10 47	S. 63° E. 11 ...
6	49.1	46.5	49.8	47.1	SE. by S.	5	SSE.	5	48.4	1.02724	49 41	8 33	N. 41° W. 11 ...
7	...	...	50.2	47.9	...	...	S. by E.	5	48.6	1.02727	50 4	4 51	... ...

* According to Captain Beaufort's scale, see Report of Committee of Physics and Meteorology of Royal Society, p. 43.

The trade-wind disappeared on the 26th, in lat. 26°. By the following morning, the wind had drawn round to SE. by E., and was attended by a considerable rise of the dew-point, as was observed outside the trade in the eastern part of the Atlantic. In higher latitudes, northerly winds caused a rapid fall of the temperature and dew-point, while a change to the southward was generally followed by the elevation of both.

The observations on the sea water, and drift of the currents, possess considerable interest. In examining these it is necessary to observe, that, while the temperature and specific gravity of the water refer to a given point only, the drift of the current is that observed during the previous twenty-four hours; so that were a ship to run from still water into a current a little before noon, the temperature and specific gravity of the water of the current would be obtained, though the drift would not become obvious until the following noon. Also, were a ship, at noon, near the edge of a current, sailing out of it into still water, the disappearance of the current, which would become obvious from next day's reckoning, should be associated with the temperature and specific gravity obtained that day, and *vice versa.*

The great equatorial current, directed to the NW. by the coast of South America, sets past Barbadoes and the islands to leeward, into the Caribbean Sea, with considerable velocity. To the northward of Barbadoes, however, for some distance, whether from the islands being more thickly grouped, or from the diminished depth of the sea, the current seems altered in direction. From Barbadoes to 15° 17′ N., for instance, the general drift was, on the 10th and 11th February, N. 82° E., seven miles; from that latitude, however, to 17° 41′ N. the drift in the following twenty-four hours was, N. 50° W., eight miles; and, up to next noon, when completely clear of the leeward islands, it was, N. 68° W., twenty-nine miles. The vessel seems to have left this current just before noon on the 13th; for, although the temperature of the water was then the same as on the preceding day, its specific gravity on the 12th was 1·02801, and on the 13th 1·02774 only; the drift, too, up to noon on the 14th, was, N. 34° E., seven miles, and to the same time on the 15th, N. 14° E., four miles, the same in both, while the specific gravity on the 14th was 1·02770, almost identical with what it had been the previous day.

About mid-day on the 15th the ship again seems to have run into a current, setting to the NW, for the specific gravity of the water had then increased to 1·02802; the following day it was 1·02814, and on the 17th 1.02811; the set of the current up to noon of the 16th was, N. 63° W., twenty-two miles; on the 17th, N. 15° W., twenty-four miles, and on the 18th, N. 55° W., twenty-one miles. The extraordinary similarity in the direction and velocity of this current, and in the specific gravity of the water, with that experienced on the 12th and 13th, obviously shew a community of origin: whether this current were continuous from 20° to 24° N., and was merely covered by another of less specific gravity, flowing to the north and east, is impossible to say; but it is a subject deserving farther investigation.

It is worthy of observation, that the specific gravity of the water increased considerably on the 16th while in the current; the temperature, too, fell 1°.1, and on the following day the decrease of temperature was 3°·5, the specific gravity remaining nearly the same. Accompanying these, there was a remarkable change in the direction of the current on the 16th and 17th, which was much more to the northward than on either the preceding or following days. The increase of specific gravity, and rapid diminution of temperature, would indicate that water from a considerable depth was directed to the surface by some inequality of the bottom, while the water, being heaped up over the obstruction, would naturally flow off to either side; and hence the more northerly direction of the current on the 16th and 17th. Any one may have a familiar illustration of this by watching the eddies produced in a small stream by the stones at its bottom.

The distribution of temperature during the summer, over the space occupied by these currents, is remarkable. The following observations, made by Mr Battersby, 47th regiment, in September 1841, indicate that the north-easterly current has then a temperature considerably higher than the NW. one on either side of it. The error of the thermometer employed has been eliminated.

			Temp. of sea. Noon. °
Sept. 3.	Lat. 17° 20′ N.	To the eastward of the Leeward Islands.	81.7 Fahr.
4.	... 20 18 ...		80.7 ...
5.	... 22 16 ...		82.7 ...
6.	... 23 44 ...	Long. 64° 12′ W.	82.7 ...
7.	... 24 41 ...	...	82.7 ...
8.	... 25 35 ...	... 62 12 ...	81.7 ...
9.	... 27 26 ...	...	80.7 ...
10.	... 29 51 ...	... 59 36 ...	80.7 ...
11.	... 31 15 ...	...	79.7 ...

A large field of sea-weed is found over nearly the same space occupied by these currents, but I unfortunately omitted to note its position, and have not since been able to procure observations on it, sufficiently close to the localities of the above observations, to be of any use in connecting them. Humboldt supposes that the weed composing these fields is detached from the bottom by the equatorial currents, a view certainly favoured by the disposition of the currents noticed above.

The ship seems to have left the current last mentioned a little before noon on the 18th, for the specific gravity of the water was then 1·02786 only, and the drift during the following twenty-four hours, N. 29° E., thirteen miles. At noon on the 19th, however, the specific gravity of the water had again risen to 1·02794, and the ship was drifted N. 68° W., forty-nine miles up the next noon, the specific gravity of the water remaining much the same. The drift, up to mid-day on the 21st was, at 68° E., forty-three miles, and by that hour the specific gravity had again fallen to 1·02782, the ship having passed from a westerly to an easterly current soon after noon the preceding day. The changes of temperature on these days, too, display certain irregularities, which, though slight, and if taken alone, of no great weight, still, when associated with the observed differences in the saltness of the water, and the set of the currents, assume much more importance. Thus the fall of temperature from the NW. current on the 17th, to the NE. one on the 18th, was 1°·0; the fall from this to the NW. one on the 19th, 1°·3, and, on the 20th, while in this current, only 0°·7; the following day, however, with a strong NE. current, and diminished specific gravity, the temperature of the water fell 1°·9; and on the 22d, while a NE. current of the same specific gravity as on the 21st continued, the diminution of temperature was 0°·9 only.

The cause of the extraordinary whirl on the 20th and 21st it is not easy to make out. The ship was then about east from the Bermudas, and not very distant from a cluster of rocks which are often mistaken for these islands. It is possible that irregularities of the bed of the sea, connected with these, might have produced the eddies in question.

The current on the 23d was, N. 84° E., ten miles, and the water had a specific gravity of 1·02796, almost identical with those of the 19th and 20th; and on the 24th the ship was in the Gulf Stream, as laid down in the chart. The specific gravity of the water was then 1·02770, and on the following two days it increased a little, the temperature at the same time diminishing considerably, especially on the 26th, as the northern edge of the stream was approached. As the NW. currents between the Antilles and Bermuda flow into the space between the latter and southern margin of the Gulf Stream, that portion of the water which reaches the edge of the stream must be gradually turned to the eastward along with the stream: the high specific gravity of the water on the 23d (which did not follow the regular course of the stream) can thus be accounted for; and farther, a rational explanation will be found for the rapid enlargement the stream itself undergoes a little to the northward of the Bahamas. An allowance has been made for the drift of the Gulf Stream on the 24th and 25th; but as I am unable to state the amount, I have given the numbers in the table without alteration.

On the 27th the specific gravity of the water was only 1·02729, and the temperature fell 3°·8 from that on the preceding day, while the drift was N. 68° W., six miles; all indicating that the Gulf Stream had been passed.

It is usually supposed that, at some distance to the westward of Ireland, a part of the Gulf Stream is directed to the NE., and flowing along the western coast of the British Islands, even reaches that of Norway. The drift of the ship, from the 1st to the 3d of March, seems to afford evidence of this; but, from the 27th February, the wind had been so variable in direction and force, that the superficial currents produced by it go far to destroy any faith that could be placed in observed drift. Thus, on the afternoon of the 27th February, at 3 P.M., the wind was north, with a force of 7; about 9 its force had increased to 10; it continued at north during the night, blowing hard, and early in the morning drew round to NW. The drift during these twenty-four hours was S. 25° W., twenty-one miles; and on the following day it was S. 45° E., sixteen miles, the wind having been mostly from the NW., and fresh. On the 2d and 3d March the drift was, N. 61° E., twenty-three miles, and, N. 82° E., twenty-nine miles respectively; but from the evening of the 1st to the morning of the 3d it had blown hard from the SSW., and had then backed to NW. by W.; the amount and direction of the drift, however, indicate a general motion of the water to the north-eastward.

From the 28th February to the 3d March the temperature of the water diminished rapidly, and its specific gravity varied from 1·02758 to 1·02712, fluctuations that might naturally be expected along the outer edge of the Gulf Stream, under the influence of the gales then experienced.

The drift on the 4th March was, S. 18° W., thirteen miles; on the 5th, S. 63° E., eleven miles; and on the 6th, N. 41° W., eleven miles. The ship reached soundings on the afternoon of the 5th, and passed into that current which is laid down in the charts as flowing along the eastern shores of the Bay of Biscay, and across the entrance of the English Channel. The water of this current presented a muddy appearance, and was cooler, and of a somewhat lower specific gravity than that to the westward of it.

The disposition of the currents in the Northern Atlantic, leading, as it does, to a peculiar distribution of temperature in the surface of the sea, gives rise to some important considerations as to the causes of its storms, and the localities in which they originate. Since the appearance of Colonel Reid's work on Storms, it has been frequently supposed that hurricanes originating in the West Indies might even extend to this country, and that the course of these storms was in some measure directed by the Gulf Stream. That storms are frequent along the outer margin of the Gulf Stream, every year's experience testifies; but there is no evidence that most, or, indeed, many of these, come from the West Indies; on the contrary, there is every reason to conclude, not only that they are produced along the polar margin of the stream, but that the greater part of those experienced in the Northern Atlantic, and in this country, originate in the same place.

In Table II. it will be found that the temperature of the sea fell 5°·6, between lat. 40° 25′ N. and 42° 40′; while, on either side, the progressive changes of temperature were much more gradual. The observations of Mr Battersby, noticed above, give even a greater change. Thus, on Sept. 21. 1841, in lat. 44° 16′ N., long. 34° W., the temperature of the surface was 70°·8; and the following day, in lat. 45° 4′, and long. 31° 10′, it was only 62°·1; while, on either side, the changes were small and tolerably regular. Observations in the eastern part of the Atlantic, too, from the Azores towards the Lizard, shew a rapid change in the temperature of the water, a little to the northward of the former. Thus, if a line be drawn across the Atlantic, from the southern part of the banks of Newfoundland to Cape Finisterre, it will nearly indicate the division between the colder and warmer waters of the Atlantic. The position of the line varies at different seasons of the year, but that mentioned is sufficiently near for general purposes.

As the mean temperature of the air over the open sea is generally somewhat under that of the surface water, the temperature of the air to the north of the line above mentioned must generally be considerably less than that of the air to the south of it. Now, it is clear that there never can be a state of equilibrium between two masses of air, so different in temperature, placed so close together, but a current of cold air would flow to the south of the line from the north, while the warmer air would rise in the atmosphere, and flow off to the north, above the lower and cooler currents, precisely as is the case with the trade-winds, only, the difference of temperature of the two currents being greater, the resulting currents will be more violent while they last, and less regular in their appearance.

On referring to Table II. such will be found to have actually occurred. Thus, on Feb. 24, at 3 P.M., the wind was SSW., the temperature of the air 65°·0, and the dew-point 62°·0; the following morning* the wind was N. by E., the temperature of the air 53°·4 only, and the dew-point 46°·6, while the temperature of the sea at noon was 62°·3. Here the passage of the cold air from the northward is obvious enough, and, as is usual in gales in the northern hemisphere, the wind, the same evening and following day, gradually backed round to the westward, and blew hard. On the afternoon of the 27th, the ship being then just on the edge of the colder water, the wind again came to the north, and freshened rapidly from the same point towards evening; about 9 P.M. its force was 10; during the night it gradually backed round to the north-westward, blowing hard, just as in the previous instance. In these two cases the ship was in the northern part of the gale; but, on the 2d March, another was experienced from SSW., which, by the following morning, had veered to NW. by W., the southern part of which only had passed over her.

Mr Battersby experienced similar weather between lat. 43° and 47° N., from the 20th to the 24th September 1841; and the shipping intelligence of every year contains abundance of evidence of the same description.

On the occurrence of Phosphoric Acid in Simple Minerals and Rocks.

Dr Fownes of London, in a published memoir, announced that he had discovered phosphoric acid in rocks generally believed to be of igneous origin—as in the grey vesicular lava from the Rhine, the white trachyte of the Drachenfels, in basalts, porphyritic lava of Vesuvius, and in volcanic tufa from the same mountain. Professor C. Kersten of Freyberg, however, declares that he was unable to detect *the least trace of phosphoric acid* in such rocks. In the September number of the Philosophical Magazine (year 1845), Wm. Sullivan, Esq., of Dublin, publishes the following list of the rocks and minerals which he examined for phosphoric acid. He notices, also, those in which potash and soda occur—that is, those rocks in which these substances had not hitherto been noticed:—

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* The moon was in perigee on the 24th, and full at 4 h. 15 m. A.M. on the 25th.

Rocks.	Phosphoric Acid.	Alkalies.
Nine varieties of *carboniferous limestone* from the neighbourhood of Cork.	In all I could detect its presence, and in one it occurred in sufficient quantity to be determined.	Potash was found present in all, but in such small quantity that I could not determine it. From the same cause I could not determine whether soda was present.
Muschelkalk and *dolomite* from the same formation, from near Fulda in Hesse-Casel.	Present, but apparently more abundant, in the dolomite.	Minute traces.
Roofing-slate used at Giessen.	Considerable precipitate, but *wavellite* is found in some localities in the same rock.	Large precipitate, with chloride of platinum and a small trace of soda.
Flags used in the west of Ireland, supposed to be *millstone grit*.	Traces, but very minute.	Trace of potash, but could not ascertain if soda was present.
Slate from Corrigaline, near Cork.	Precipitate large enough to examine quantitatively. [This is the best locality known, I believe, for wavellite.]	Decided precipitate with chloride of platinum. Sufficient soda to produce a precipitate with antimoniate of potash.
Old red sandstone, Cork.	Trace in one specimen, but a decided precipitate was obtained from three ounces of another.	Could not detect soda, but detected a trace of potash.

Simple Minerals and Rocks.	Phosphoric Acid.
Diorite containing augite, from the valley of the Lahn, Nassau.	Obtained sufficient from two ounces to test with nitrate of silver.
Clinkstone, from Rhöngebirge, Bavaria.	Abundant traces.
Phonolitic Tufa, Rhöngebirge, Bavaria.	Considerable precipitate.
Hornblende in crystals, from Rhöngebirge.	Minute traces.
Olivine, in a state of decomposition, from the Vogelsgebirge, Hesse-Darmstadt.	Sufficient to apply the test of nitrate of silver; but three ounces were employed.
Augite, crystalline, Rhöngebirge.	Abundant traces.
Compact basalt, from Giessen.	Considerable traces.
Trap rock of the nature of greenstone, from the north of Ireland.	Only minute traces in one specimen, but in considerable quantity in another.
Basalts, Giant's Causeway.	Enough to produce a precipitate with sulphate of ammonia and magnesia from two ounces.
Pumice stone, from the Lake of Laach, near Andernach, on the Rhine.	Considerable precipitate from three ounces.
Sodalite, Vesuvius.	Trace; had not enough for a second analysis.
Variety of *hypersthene*, occurring in the diorite on the Lahn, Nassau.	Distinct traces.

Simple Minerals and Rocks.	Phosphoric Acid.
Lepidolite, locality unknown.	I obtained so large a precipitate, that I think it must form an important constituent of this mineral.
Obsidian, from Lipari.	Present in considerable quantity.
Mica, Spessart, Bavaria.	Minute traces, but more abundant in another specimen from Russia.
Granite, Odenwald, Germany.	Enough to give all the usual tests from about 1½ ounce.
Chlorite slate, locality unknown.	Sufficient from two ounces to give a precipitate with nitrate of silver.
Augite porphyry, locality unknown.	Considerable traces.
Mica slate, locality unknown.	Enough for nitrate of silver test.
Gneiss, Odenwald, Germany.	Considerable traces from two ounces.
Two specimens of Scotch *granite*, localities unknown.	Large precipitate from two ounces.
Tincal, or native borax, from East Indies.	The quantity of phosphoric acid in this substance was very considerable, being equal in one instance to 2·13 per cent. I think most native borax will be found to contain phosphate of soda.
Datholite.	In one specimen of this mineral from Andreasberg in the Harz, the quantity of this acid present was sufficiently large to be estimated. I also detected its presence in a specimen from North America, but in neither case had I enough of the mineral to make another analysis.

It is very curious that such a large quantity of phosphoric acid should in these two cases be associated with boracic acid, which is of a decided volcanic origin. It would be very interesting if the substances occurring with the native boracic acid in Tuscany, and also the other minerals containing boracic acid, were examined for phosphoric acid. The quantitative determination of the phosphoric acid in rocks would, in my opinion, be of little importance, as phosphoric acid, although a constant, is a very variable constituent. This, however, does not apply to the simple minerals, such as olivine, of which it forms very probably a constant constituent.

On the Analogies observed in Chemical Unions. By ARTHUR CONNELL, Esq., F.R.S.E., Professor of Chemistry, University of St Andrews. Communicated by the Author.

In the following observations an attempt is made, by a reference to various analogies in nature, to illustrate and support some of those views regarding certain important chemical unions which are more or less adopted by most chemists.

In surveying the works of creation, one of the principles which strikes us most forcibly is unity of design, a character which we naturally look for in the workmanship of a great First Cause. In the animal and vegetable kingdoms, we observe a uniformity of plan everywhere exhibited in the structure of the various organs of the several classes and individuals of those kingdoms; and we are almost always able to fix on some type applicable to each family or each set of organs. The degree of perfection, however, in which individual structures reach this type, differs much in different instances; and we usually can trace a more or less regular progression in the approaches to the standard. At the one extremity of such a series we notice little deviation from the model, and at the other, we not unfrequently observe so great an apparent disconformity, that the resemblance is only remote. To this latter class of cases belong such organs as are called rudimentary by physiologists, in which some particular structure is incompletely developed, and of which we should hardly be able to understand the purpose, did not more extended observation enable us to perceive, that it forms the extremity of a series of connected organs, modelled upon a common type, which they resemble, to a variable extent, in structure and functions.

Although Nature generally employs only one set of organs in the same individual for any given purpose, yet we occasionally observe, particularly where a change occurs in the condition of the individual, that the organs applicable to some common purpose in the different states co-exist, at least, during certain periods, so that we then find more than one set applicable to such common object. In such a case, however, those organs naturally belonging to the new condition will be reckoned the proper and peculiar appendage, whilst the others will be viewed as adventitious and imperfect, with reference to the new state.

In the mineral kingdom there are, of course, no organs, but we find, in most instances, a structure or arrangement of particles; and we also notice a progression in the degree of perfection in which this character is discoverable. In many cases the forms assumed, are in the highest degree regular and mathematically accurate in their various proportions. In other instances, although we can easily trace the geometrical arrangement, they are more or less irregular in their details. In other cases, we do not find that mathematical forms are actually assumed; but we observe a certain structure of the shapeless mass, which admits of separation in particular directions, corresponding to fixed geometrical figures, similar to those which other bodies are found actually assuming; and the same substance is often found at one time in the actual mathematical form, and at another in the shapeless mass possessing the regular structure when divided. We can have no hesitation in considering this cleavage as rudimentary crystallization.

When we come to examine the objects of inorganic nature, whether natural or artificial, with reference, not to structure, but to chemical qualities, we can still discover the relation to some type or standard, and a progression in the degree of approach to this standard in different instances. In many cases, although it is not difficult to discover the type on which a compound has been formed, yet the result is an imperfect one, with reference to that type.

If we turn our attention to the leading chemical characters of elementary bodies, we find that their combinations with oxygen may be either bases or acids; and, in like manner, the compounds which they form with hydrogen, may be either bases or acids. We have examples of hydrogen bases in ammonia, in several hydro-carbons, and in phosphuretted-hydrogen, all of which can be shewn to possess, in a greater or less degree, the character of bases. The combinations called salts are usually formed between oxygen acids and oxygen bases, or between hydrogen acids and hydrogen bases, and, more rarely, between the acids of the one class and the bases of the other.

It appears to be certain that ammonia possesses, *per se*, the character of an alkaline base. In the gaseous state, when perfectly dry, it still acts on dry test papers; and when perfectly dry ammoniacal and carbonic acid gases are mixed together, the white salt formed by their union has a strong ammoniacal odour, and yields ammonia when heated with recently ignited quicklime, subliming in part unchanged. Its solution in water precipitates lime salts, and effervesces with acids. But if ammonia, *per se*, is an alkaline base, are we, on that account, to reject the idea of the existence of ammonium and its oxide? I think that we are not bound to do so; but we shall be better enabled to admit the existence both of the alkali ammonia and the alkali oxide of ammonium, if we call in the aid of some of those analogies to which I have been alluding. The compound of a hydracid with an oxyalkali has a constant tendency to pass into the state of a haloid salt, by losing the elements of water. The compound of an oxyacid with a hydralkali, in the anhydrous state, exists rarely, and the constituents are not usually in their proper condition of acid and base, as we see in anhydrous sulphate of ammonia. The natural tendency of ammonia, as a hydralkali, thus is, not to combine with oxyacids, but rather with hydracids; and we have instances of such unions in muriate, hydrobromate, and hydriodate of ammonia, &c.

On the other hand, the natural tendency of oxyacids is to unite with oxybases, at least with a view to the formation of permanent and distinct compounds; and thus we are led to certain peculiarities in their apparent unions with hydrobases. When we find ammonia apparently entering into union with oxyacids, we usually discover the elements of an atom of water also existing in the compound. To what are we to attribute this fact? I apprehend the solution is to be found in a disposition of nature to pass into a new analogy, or new series of combinations, moulded on a different type from the proper ammoniacal saline compounds. To enable a hydralkali to form a compound with an oxyacid, it must in some way fulfil the condition of passing into the state of an oxyalkali; but, as the hydrogen compounds constitute the proper and principal series of hydrobase unions, we need not look for the same perfection of purpose in carrying out the new analogy. Ammonia, by uniting with the elements of an atom of water, passes into the condition of oxide of ammonium, a base belonging to a different series, and of a less perfect nature. It is less perfect than ammonia, because it cannot exist in an uncombined state, and because its salts are decomposed by heat, whilst the hydracid salts of ammonia sublime unchanged; and, for similar reasons, it is less perfect than potash or soda, considering it as belonging to the series of oxyalkalies.

In this way we have both the alkali ammonia and the alkali oxide of ammonium; the leading tendency of the one being to combine with hydrogen acids, and of the other with oxygen acids; but the one being, in all its relations, of a more perfect character than the other. They belong to entirely different types, the one being the most perfect of hydrogen bases, and the other being one of the less perfect of oxygen bases, and having a compound radicle.

Its radicle ammonium may be viewed as an imperfect member of the metallic series. It is formed, in respect of properties, on the type of the metals, but has scarcely a substantive existence. Facts, however, appear to tell us, that it is not altogether imaginary. The metallic appearance of the ammoniacal amalgam leads strongly to the idea, that the mercury has combined with something which does not mineralize it, but is metallic like itself. And when this occurrence is taken in connection with the usual constitution of the oxysalts of ammonia, and their bearing on isomorphism, we certainly see strong grounds for holding ammonium and its oxide to have an existence, although of a more or less temporary nature; and, therefore, imperfect, as regards other metals and bases.

It appears to me, that it ought to be considered as entering into our view of the natural tendency of hydrobases to combine with hydracids, that the primary affinity may often result in such an arrangement of the constituent atoms, that a haloid salt of ammonium instead of a hydracid salt of ammonia shall be formed. There are evident traces in these compounds of a double type, and of a ready transition of the one into the other; and it is not always easy to say when the one arrangement and when the other actually takes place. It is really not of great importance whether the atom of hydrogen is in more immediate connection with the halogen or with the other elements of the compound metal. It may oscillate, so to speak, between the two, and take its ultimate position according to circumstances, as it appears to have affinities for the latter as well as the former. Nothing is thus added nor taken away.

The series of hydrogen bases is a pretty extensive one, and it appears to pass by an easy transition from inorganic to organic nature; and through the whole series we observe a strong analogy of relations. Next to ammonia, we may reckon certain hydro-carbons; and, first, the combination $C^4 H^4$. This unites with the hydracids, and forms the haloid ethers, such as muriatic ether, $C^4 H^4, Cl H$. To combine with oxyacids, it must, like ammonia, change its type; and it accomplishes this in the same way, through the aid of the elements of water. It thus becomes common ether, $C^4 H^5 O$, and then unites with oxyacids to form the ordinary saline ethers, such as hyponitrous ether, $C^4 H^5 . O + N O^3$. All these combinations, although formed on the type of the ammoniacal compounds, are of an imperfect character as saline bodies, the different acids not producing in the compounds their ordinary reactions. Although the analogy has determined the union, yet the result is of an imperfect character as a salt, the acid and alkali appearing not to have ultimately united as such.

Analogy would lead us to infer the existence of a compound metallic substance, $C^4 H^5$, analogous to ammonium, but no other evidence than inference from its combinations has yet been brought to light. I tried to decompose ether by direct voltaic agency, and likewise to form an amalgam, by galvanizing a globule of mercury placed in alcohol, but without success. It is probable, therefore, that although ether is formed on the type of the metallic bases, yet the actual result is modified, so as to have as little the constitution of a true oxide, as its combinations with acids have of true salts.

In all such unions, we may bear in mind, that although the analogy or type may *determine* the union, as, for example, between the elements of ethyle and oxygen, and between ether and an oxyacid, yet the compound actually resulting may not contain the radicles as such; but a new arrangement of elements may take place, and the result be, to that extent, imperfect. We may consider oxide of ammonium as forming the transition between perfect oxides and those still less perfect than the connecting link.

The hydro-carbon $C^2 H^2$ affords the pyroxylic series, on entirely analogous principles to the alcohol series.

Another series of this kind, not yet fully developed, appears to have the hydro-base $C^{10} H^{10}$ as its foundation. We have the hydrate of the oxide of the series in potato-oil $C^{10} H^{11} O + HO$, corresponding to alcohol and pyroxylic spirit; and various saline ethers, although its simple ether has not yet been formed.

Phosphuretted-hydrogen $H^3 P^2$ may be regarded as a member of the series of hydrogen bases. It unites directly with hydracids to form crystallized compounds. From the inferior tendencies, however, of hydro-bases to unite with oxyacids, it has not much affinity for the latter; but the disposition to follow out the analogy is manifest, for, by the experiments of Buff and Rose, it is absorbed by oil of vitriol, and the solution remains for a certain time undecomposed; during the temporary union passing, perhaps, into the state of an oxybase in the usual way. Ammonia expels it as one more powerful base does another.

Such are the hydro-bases having simple radicles, so far as at present known; but there appears to be a farther numerous series of allied combinations, of more complex constitution, and belonging properly to organic chemistry; and into the constitution of all of these hydrogen enters along with carbon, nitrogen, and usually oxygen. The several vegetable alkaloids are the principal instances of this kind. These follow exactly the analogy of ammonia in their combinations. They are, in their separate state, strongly alkaline. They unite directly with hydracids to form salts. In combining with oxyacids, they change their type, passing into the state of oxybases through the intervention of the elements of water. We have yet, however, no evidence of the separate existence of a radicle analogous to ammonium. I did not find any such evidence when a globule of mercury was submitted to voltaic action in a solution of muriate of morphia, or when it had been previously alloyed with sodium; neither does it seem to be necessary, as will be presently noticed, that the pure alkaloids themselves should be held actually to contain radicles, *as such*, united to hydrogen.

Next to the vegetable alkaloids, the artificial bases, such as melamine $C^6 N^6 H^6$, and ammeline $C^6 O^2 N^5 H^5$, &c., may be noticed as coming under the same general laws.

Urea $C^2 O^2 N^2 H^4$ may be classed in the same list, for, by late experiments, its muriate does not contain the elements of water, whilst its oxysalts do.

By late experiments, also, the xanthic oxide (xanthine) $C^5 O^2 N^5 H^5$ appears to be a base of a similar character, although there seems to be this peculiarity, that it requires two of the single atoms of the base, which combine with hydracids to unite with the elements of one atom of water, and pass into the oxygen base series.

If we leave the series of bases and turn to that of halogens (salzbilder), we discover the same proofs of approaches to a type differing in the degree of perfection to which the result is carried. After the simple halogens, chlorine, bromine, &c., the most perfect and least complex of the compounded ones is cyanogen $C^2 N$. As ammonia is modelled on the simple metals, so cyanogen is moulded on the simple halogens, and analogy guides their respective combinations. Hydrocyanic and cyanic acids have their prototypes in the analogous combinations of the simple halogens, although they fall behind them in the perfection of the result.

Next come ferrocyanogen and sulphocyanogen. In these the analogy to the simple halogens has been followed out in considerable perfection, although the constitution is very complex, and these compound halogens themselves have not yet been distinctly isolated. The type is quite manifest.

Mellon $C^6 N^4$ ranks next, with its hydracid $C^6 N^4 H$, and numerous haloid salts.

Three well-known essential oils, the pure oils of spiræa ulmaria, bitter almonds, and cinnamon, connect, in a very interesting manner, inorganic and organic nature, by presenting, particularly the first mentioned, a strong analogy between simple halogens and compound ones, although not yet isolated. The spiroil or salicyle series has an analogue for almost every combination of chlorine or iodine. Its hydracid $C^{14} H^5 O^4 + H$, has weak but decided acid properties. Its haloids are true salts often crystallized. The other two series are less perfectly developed, the haloid compounds being awanting, and the hydrogen combinations scarcely acids. The type, indeed, of cinnamyle, if isolated, would rather be such a substance as phosphorus, than the more perfect halogens; for its hydrogen compound is rather a hydrobase than a hydracid; uniting with oxygen acids by the intervention of water, and with anhydrous hydracids. As it combines, however, also with ammonia, there is, in some measure, a double type. The approach to inorganic types is manifest in all the three series, although, as usual, in a variable degree of perfection.

The singular combination kakodyle $C^4 H^6 As^2$, is not formed on the type of the halogens, but rather of some of the ordinary simple metals. We have its combinations with oxygen and with simple halogens, quite on such a type; and we have itself in a separate state, although not at all comparable to a metal in physical qualities, yet closely allied in chemical relations.

We have perhaps examples of imperfectly developed series in the combinations of formyle $C^2 H$, and of acetyle $C^4 H^3$. But the evidence as to these, is as yet much less satisfactory than in regard to Benzoyle.

The ordinary organic acids appear to belong essentially to the type of oxygen acids, as the organic bases belong to the type of hydrobases. They unite directly with oxybases, and, in combining with hydrobases, the latter change their type, through the intervention of the elements of water, as we see in the compounds of organic acids with ammonia and with ether. But neither in the case of the acids, nor of the bases of organic chemistry, does it seem to be essential that we should hold they actually contain compound radicles as such. The union with oxygen in the one case, and with hydrogen in the other, may be determined by a principle of analogy; and the chemical character of the resulting compound may be determined by the analogy; but the actual grouping of elements may vary from the type. We are prepared, by the principles which I have been illustrating, for such imperfections in the results. I subjected to voltaic action fused benzoic acid and fused morphia, without any symptoms of decomposition, and even without the galvanometer being affected; there thus being no evidence of binary combination.

Some leading combinations of elementary bodies amongst themselves, have thus been briefly followed out into the less perfect analogies of compound or organic radicles. It is very probable, that others of less importance might also be traced in a similar manner.

The true interest of organic chemistry, in a scientific point of view, and independently of its useful applications, seems to consist in the discovery and tracing of analogies more or less perfectly developed with such inorganic types as we have been noticing. It is these last, which are of a steady, undeviating, and consistent character, capable of being traced through the compounds of upwards of fifty distinct elements. In these combinations a beautiful analogy prevails, and this we can follow out in a manner which leaves nothing to mere conjecture. If organic chemistry were as certain and well defined in its combinations, with the difference only that the substances uniting were themselves compounded, it would afford a perfect system also. This, however, is very far from being the case, at least at present; but as it is evident that nature endeavours, as it were, to follow out, within certain limits in organic combinations, the analogy of inorganic bodies, our main object ought always to be to discover such resemblances where they really exist. There is little doubt, however, that there are other principles of combination applicable to organic bodies, deviating from the inorganic types, which we have been considering; and although it is much to be feared that they are much less well defined, and more complex and uncertain, yet it is, of course, the duty of the chemist to endeavour to discover them if he can. If they should ultimately prove to be capable of being systematised, they will form a new fabric, exhibiting its own peculiar principles of construction.

ST ANDREWS, 23*d August* 1845.

On the Diluvial Epoch. By Professor F. J. PICTET of Geneva.

The examination of a considerable number of fossil bones from the caves of France, and of the bones found in the gravel of the environs of Geneva, as well as a comparison of the different memoirs published on the organic remains of the diluvial epoch, have led me to form a different opinion from that generally entertained on this subject.

The diluvial formation is commonly regarded as separated from the modern epoch by characters as decided as those which distinguish the three divisions of the tertiary period. The naturalists who believe absolutely in the peculiarity of the species of the different formations (and, for my own part, I am of opinion that every thing tends to shew that this law is to be considered as demonstrated) think that the order of events was the same in the diluvial epoch as in the others; that is to say, that at the end of that period all the species became extinct, and that a new creation repeopled the earth at the commencement of the modern epoch.

The study of the facts does not appear to me to justify this conclusion; and, on the contrary, I think that the diluvial epoch ought to be united with the modern epoch. I believe that there was no new creation, and no interruption of organic life, between the time when the bones of bears were buried in caverns and the present period. Let me, in a few words, adduce my reasons for taking this view of the subject, and then point out what I imagine actually occurred.

The first proof I shall give is derived from the study of the arenaceous deposits in the neighbourhood of Geneva. These deposits have been very properly divided into two portions by M. Necker,—the upper, termed *diluvien cataclystique*, and containing erratic blocks, rolled pebbles, and sand, irregularly stratified; and the lower, or *alluvion ancienne*, composed of pebbles, more equal in size, and more regularly arranged in beds, so that we may suppose that they were deposited by a more gentle and more tranquil agent than that by which the upper member was formed.

This ancient alluvium covers all the bottom of the valley without ever reaching the summit of the acclivities of the Molasse: it could not have been deposited except under circumstances very different from those existing at the present day, and it has altogether the characters of the deposits of the diluvial epoch.

Now, in these ancient alluvial deposits, bones are found which prove that our valley was inhabited at that epoch by species of mammalia *perfectly identical* with those which now live there. We can detect in these bones no difference o size or of form which can authorize the establishment of any new species. On the other hand, in the bed of the Allondon, that is to say, probably in a formation of the same epoch, a tusk of an elephant has been found.

These ancient alluvial deposits are probably contemporaneous (or nearly so) with those which exist in various other parts of the Swiss plain, and in which there have been found species now living, as well as remains of elephants.

These facts seem to me to shew that the mammoth lived along with species identical with those of the present day, and to prove that there was no new creation between the deposits of which I have been speaking and those of our own period.

I find a second proof in the caverns and breccias themselves. Some species are there met with which I believe to be extinct, such as the bears of the caverns, the hyænas, and some others; but there are also found bones of a larger number of species, which cannot be distinguished from those now living in Europe. The bats, the shrews, the moles, the badgers, the hares, &c., of the caverns, appear to be identical with our own. Is it probable that they should all have differed from the species now living in their external characters, and that, having been destroyed *en masse* by diluvial inundations, they should have been replaced, by means of an entirely new creation, by species which we are not able to distinguish from them?

I am of opinion that the following is the order of events as they occurred in Europe:—The species now living, and some others, were created at the commencement of the diluvial epoch. Partial inundations and changes of temperature caused some of them to perish, such as the mammoth, the species of bear having an arched forehead, the hyænas, the stag with gigantic horns, the rhinoceros, the hippopotamus, &c.; but the greater number of the species escaped these causes of destruction, and still live. Besides those which I have mentioned, and others which I have noticed in the body of my work, it is possible, for example, that the *Ursus priscus* may be the original of recent bears, &c.

It may be objected, perhaps, that there is nothing, in this manner of viewing the subject, to account for the late appearance of man. It must be remarked, however, that it is necessary to distinguish between the creation of man and his establishment in Europe. It is probable that he did not arrive there till after the inundations which destroyed the cavern-bears and the contemporaneous animals. It may even be supposed that the last diluvial deposit, and, in particular, the arenaceous formations of Switzerland, were formed before the human species inhabited our regions. There is nothing, however, to prove that man had not been created in Asia at the commencement of the diluvial epoch. It must be remembered that the Sacred Writings, and the traditions of various nations, authorise us to believe that man witnessed some of those great inundations which were entitled to the name of deluges. Subsequently, tribes of the human race became more numerous, and migrated to Europe; and every one knows that philological, historical, and physiological researches all combine to demonstrate that Asia was the cradle of the nations which have successively invaded our continent.

Lastly, it may perhaps be said that this idea is opposed to the theory of the peculiarity of species in each formation, and to that of successive creations. I do not think so, for the question remains untouched as respects all the anterior epochs. But even though the result of this manner of viewing the subject should be to place in doubt the theories which I believe to be at the present moment the least inadmissible, I cannot, on that account, refuse to adopt an explanation of facts which seems to me evident. The state of theoretical palæontology is still too uncertain to allow of our attaching ourselves too strongly to this or that hypothesis. It is the study of facts which is essential, and we must engage in that study unbiassed by preconceived ideas or particular systems.*

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* From *Traité Elémentaire de Paléontologie*, vol. i. p. 359. 1844.

On the Ancient Inhabitants of the Canary Islands. By THOMAS HODGKIN, M.D.* Communicated for the Edinburgh New Philosophical Journal by the Society.

I have no pretension to be able to solve the ethnological problem presented by the uncertainty which exists as to the origin and affinities of the ancient inhabitants of the Canary Islands; yet I trust that a few observations and reflections bearing on this subject may not be uninteresting to the members of the Ethnological Society, although I am not prepared to say whether my remarks are more likely to lead to the solution of the question, or to serve truth in the opposite direction, by preventing the adoption of erroneous inferences.

It is many years since the inspection of Guanchee mummies induced me to believe that the ancient inhabitants of the Canary Islands were a diminutive people. It was, however, only a passing observation, which led to no particular inquiry at the time. It happened, however, that at the same period I was examining many of the animal productions of Northern and Southern Africa, in conjunction with my friend Dr Knox of Edinburgh; and we were both of us impressed with the many points of resemblance between these productions in the remote parts of the Continent. The notorious fact of the existence of a once numerous, though now greatly reduced, race of diminutive human beings in the south of Africa—the Hottentots and the Bushmen—seemed to find their counterpart in the obscure, and, undoubtedly, in part fabulous, relations of Troglodytes, formerly supposed to exist towards the north-east of the Continent. I could not avoid associating these two points with the former existence of a small race in the islands of the western coast of the same Continent. I merely noticed the coincidence, without attempting to pursue any inquiry into the subject, or even supposing that materials could be collected subservient to the investigation.

At a somewhat later period, having occasion to classify a considerable collection of human skulls, including specimens from various parts of the globe, those of Africans, and their descendants, naturally formed a distinct group. This group, however, required arrangement within itself, which might either consist in subdivision or gradual transition. In some respects the latter appeared preferable, and more accordant with the facts which were before me.

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* Read before the Ethnological Society of London, 21st May 1845.

Though the African skulls, generally, may be regarded as elongated, and possessing that peculiar character which Dr Prichard has called *Steino-bregmic*, and Prognathous, as respects the form and position of the alveolar processes, there are marked differences as respects the form of the forehead and other parts of the cranium. In some the os frontis rises almost vertically from the supraorbitar ridges, and being comparatively flat in front, makes a more prompt and decided turn towards the temples than is to be found in almost any other skulls. From the forehead, thus almost vertically formed, the upper part of the head recedes more horizontally than in those African skulls in which the opposite character of forehead is most conspicuous. An admirable specimen of a head thus formed had struck my attention in the cast of a Mosambique Negro, preserved in the Museum of the Garden of Plants, in Paris; and I found this form to prevail, I believe, without any exception, in the skulls which came from the same part of Africa. In some instances, the forehead, though vertical, was very low; but we see the same form elevated in the beautiful and capacious forehead of Leo Africanus, a learned Negro, also from the eastern part of the Continent.

In those skulls which exhibit the type which may be regarded as the opposite to that which I have just described, the forehead recedes as it rises, and, in many instances, a similar direction is continued to the posterior part of the head, producing, as Dr Knox has justly remarked with respect to some African heads, a great height from the meatus externus to the vertex. The forehead recedes laterally as well as superiorly, not only causing the turn of the temples to be less marked, but rendering the frontal protuberances, which are very conspicuous in the former type, little, if at all, perceptible in this. Skulls of this description belong, as far as I have been able to make out, to the natives of the western coast of Africa, and are not only remarkable for the comparatively large size of the bones of the face, but are often throughout of great thickness and weight. An example of this kind of head is, if I am not mistaken, exhibited in the antique statue of a Negro in the act of stooping, and which is commonly called the knife-grinder. The striking peculiarities of these heads are exaggerated in American caricatures, in which, contrasted with the fine foreheads given to the Whites, they seem designed to suggest the idea that they are scarcely human.

The skulls of Caffres present a form of forehead which is intermediate between the extremes which I have now described, the lower part of the forehead being vertical, the frontal protuberances being conspicuous, and the sides of the forehead not so much bevelled off as in the Western heads. I was, therefore, induced to believe that there was a gradual transition from the most striking examples of the first type, by way of South Africa to the Western coast, where the opposite type is the most strongly marked. I communicated these views to my friend Antonius D'Abbadie, when he was preparing himself to become an African traveller, and who, whilst devoting much of his time to the exact sciences, was not regardless of ethnographical characteristics. Circumstances having led him to visit Brazil, before his proceeding to Africa, he paid special attention to the African race imported into that country. The Portuguese, as is well known, have derived their slaves from the Western, as well as from the Eastern coast of Africa. The observations of my friend not merely tended to confirm the localities which I have assigned to forms, but on one occasion he was enabled to correct a mistake which referred an individual to the West coast, who, on more careful inquiry, turned out to be derived from the East, as A. D'Abbadie had insisted that he must have been. It is, however, highly probable that many exceptions may be met with, since it is well known that Africans pass from one part of the continent to another, making journeys occupying several months. Not only individuals, but groups may possibly be found to clash with the distribution, in the main correctly conjectured; and the Ethnography of Africa, when more completely filled up than is at present the case, may furnish examples analogous to the existence of Sclavonic families in the South of Europe.

I much regret the want of observations and information regarding the heads of Northern Africans. Independently of the northern parts of Africa having been, from a very remote period, in great measure, inhabited by Caucasian families, which, in the lapse of ages, may have sufficiently blended themselves with their African neighbours to have effected some personal changes, it seems pretty certain, from the descriptions given by modern travellers, as well as from delineations and descriptions of great antiquity, that the strictly African type which has prevailed in Northern Africa, is not precisely the same with that which is now to be found either on the east or the west coast, or in Southern Africa. I shall not be greatly surprised, if, in purely physical characters, there should hereafter be discovered, as in other zoological productions of the country, an approach to those characters which are met with towards the Cape.

The difficulty of the inquiry into the origin of the ancient inhabitants of the Canary Islands, is increased by the circumstance, that the African relations with the Canary Islands, in remote ages, would, in all probability, have been with the Northern tribes, of which, unhappily, too little is known. From the statues and drawings made by the ancient Egyptians, and which have been preserved to the present time, it would appear that there existed in the north of Africa a large proportion of individuals possessing the intermediate character between the Caucasian variety and that of the Negroes. The colour, which is not to be strictly relied upon, is a sort of swarthy red; the lips are thick; the eyes are full, and the nose somewhat flattened; yet these features, as contrasted with those of the Negro, are far more delicate and regular: the hair is not frizzled; and, in males, the chin is furnished with a beard of some length. Major Denham has described a people, still to be found in the northern parts of Africa, distinguished alike from the Caucasian Arabs who live near them, and from the numerous Negro tribes with which they are brought into contact by the slave-dealers, who collect their captives from various parts of the Continent. Their complexion is described by the Major as reddish, and his pen and his pencil alike suggest the resemblance between this people and the ancient race before alluded to.

I regret that I have been unable to examine skulls, either ancient or modern, belonging to this group. Differing, as they do, from both of the forms of the Negro head which I have already described, and yet, for reasons which I shall presently glance at, to be regarded as a strictly African, rather than as an outlying Caucasian branch, it would be very interesting to search for some peculiarity of conformation characteristic of the Ethiopic variety in all its subdivisions. If such a peculiarity exist, I have not at present any positive idea as to what it may be. There is, however, a peculiarity which, I think, I have noticed in all skulls of truly African Negroes. The ossa nasi are nearly parallel to each other, especially at the upper part, which confers a breadth as well as flatness on the bridge of the nose. I think that the nasal processes of the superior maxillæ, and the ossa unguis, have somewhat corresponding modifications. I am unable to say whether the Galla skulls present these peculiarities; but with the dark complexion of the skin there is so marked a difference between the form of their features and those of other African tribes, that it seems impossible not to infer so strong an admixture from another stock, as to account for the deviation from the common rule, if it exist. In the darkest Blacks of the Indian Archipelago and of New Holland, the former having woolly hair, and the latter not, the peculiarity of the African ossa nasi is not met with, so far as I have been able to discover; but in the Australian Blacks, I have noticed, in the os frontis, a remarkable form in the outer part of the orbit, giving great breadth and flatness to that part of the forehead.

As I have already stated, the observations which I have just offered have been made with sole reference to physical character, without any bias from philological or genealogical data. That local influences, as well as parentage, may produce some visible effects on the physical form, can hardly be doubted; but it seems highly probable, that the local influences are not only by far the more limited, but that they will be found, when carefully investigated, to be of such a nature that they may be taken into account, when the characteristics of family or variety are under consideration.

In the valuable pages of my friend James M'Queen, we have had thrown before us a condensed abstract of the distribution of African tribes; and the light of history, from the most distant period to the present time, gave us a hasty glance at their ascertainable ties of kindred. The striking points became obvious, but the details demand and merit closer and prolonged inspection.

From our friend Dr Latham we have repeatedly had a lucid exposition of the fact, that languages differing widely as to the words of which they are composed, may be so similar, with respect to their grammatical construction, that the philologian could not hesitate to unite them in a common group. If I am not mistaken, the African languages constitute one of the best marked and circumscribed of these groups; and I am glad to be able to add to the value of the necessarily meagre paper which I am offering on the present occasion, the results of Dr Latham's examination of the fragments of the ancient language spoken in the Canary Islands. You will, doubtless, be led to infer from them, as I had previously done from an inquiry respecting the stature of the Guanchees, that the Canary Islands have been visited by different branches of the African stock, prior to their invasion by the Spaniards and Portuguese, who in a short time have extirpated all living traces of the races which preceded them. We have, therefore, merely a few dry bones and scanty remains of nascent civilization to aid in the solution of the ethnological problem which I announced in the commencement of this paper.

It is well known, that the race which formerly inhabited the Island of Teneriffe resembled the ancient Egyptians in this particular, that they carefully preserved the bodies of their dead, having recourse to processes by which decomposition was retarded. There was also some resemblance in the destination of the bodies so prepared, as they were placed in regular order, in the erect posture, in dark and secluded chambers expressly devoted to this purpose, although the Egyptians reared those gigantic structures, to which Martial has applied the term of *barbara miracula*, and thus obtained sepulchral chambers which were altogether artificial; whereas the Guanchees took advantage of the natural caverns which their volcanic region offered them in ample numbers. The cave-temples and tombs of Upper Egypt sufficiently evince that even in this particular a resemblance existed.

The inspection of Guanchee mummies brought from the caves of Teneriffe to enrich anatomical collections, contrasting, by their small dimensions, with those of Egypt, had strongly impressed me with the idea that the extinct inhabitants of the Canaries must have been a people of rather diminutive stature, resembling, in this respect, the Hottentots of Southern Africa, and some of the past, if not of the present, inhabitants of the eastern part of the same continent.

It was with considerable surprise, that I observed that this idea of the stature of the Guanchees was by no means borne out by the historical account of this people, left on record by the European conquerors of those islands, or their immediate successors. Our learned countryman, Dr Prichard, when treating of the Guanchees, in connection with those African races to which they evidently belong, speaks of them as of considerable stature, and great bodily power.

Sabin Berthelot, Secretary of the Geographical Society of Paris, and a member of the Ethnological Society of that city, in a paper presented to the last named Society, has given an elaborate account of this people, compiled from a great variety of early authorities, which abounds with notices of the extraordinary bodily power of this people; and the indications which he gives of their physical character, are not at all consistent with their having been a small race of men.

Edrisi states, that an expedition from Lisbon, in the commencement of the twelfth century, found the natives of the Canaries possessing barks, living together in houses, and under the command of a king; that they were men of high stature, reddish-brown complexion, but indubitably of a White race, since they had long hair. Their women were of extraordinary beauty. In 1341, they were again visited by the Portuguese and Spaniards. Most of the inhabitants were then nearly naked; yet they possessed houses, well-built, of hewn-stone and strong wood-work. They had strong vigorous limbs, but were not remarkably tall. It is said that they were "Satis domestici, ultra quam sint multi ex Hispanis." The

Chaplains of Bethencourt, the contemporaries of the first conquest, which took place early in the sixteenth century, thus expressed themselves:—"Go all over the world, and you will not find finer or better formed people. They have great capacity, if they had but instruction. Their women are very beautiful, and wear their hair tied in tresses behind. This people are of high stature; they can scarcely be taken alive, for they run like hares."

Cadamosto, who relates that some of the islanders were occasionally taken and sold as slaves, says, "that they ran and bounded among rocks and precipices with the lightness of goats, and their leaps were beyond belief; that they had also great strength of arms, and that they could throw with the greatest precision." He adds, "I hence conclude, that this race of men is the most skilful and active in the world."

Viana, who published in 1604, says, "Les Guanches étaient des gens vertueux, honnetes et braves; en eux se trouvaient réunies les plus belles qualités: magnaninisté, adresse et courage, formes athlétiques, force d'âme et de corps, fierté de caractère, noblesse de maintien, physiognomie riante, esprit intelligent et dévouement patriotique."

Though it is recorded by the Chaplains that they had strongly-built houses and fortifications, it is believed that many of the inhabitants took advantage of the several caverns which abounded in the country, and lived as troglodytes. The natives of a part of Fortaventura, were remarkable for the height of their stature. The natives of Ferrol are said to have been of middle stature; those of Gomer resemble them in this respect, but are renowned for their strength and activity, which was particularly shewn in the address with which they avoided missile weapons.

The Guanchee females are also said to have been remarkable for their strength and courage. When the Spaniards had landed at Tazacorte, Guarinfanta opposed them. At first she was obliged to fly by their number; but she deceived them by a feigned flight, and retracing her steps, seized one of them and carried him off, and was about to throw herself over a precipice with him, when eight soldiers overpowered her. The women of Palma were, for the most part, of manly courage, and raised themselves to a par with men by their strength and bravery. It is worthy of remark, that the women of this and some other islands, were unable to suckle their children, and had recourse to goat's milk and artificial means.

The Haouarythes of Palma were large and robust. There was nothing unpleasant in their countenances, and their features were regular. Their Prince Mayantigo, was called "portion of heaven," on account of his beautiful countenance.

Galindo has described the gymnastic exercises most in vogue amongst the people of Fortaventura. Two men held a long spear by its extremities, raising it as high as possible over their heads, whilst their companions had to leap over it. The islanders were so active at this game, that they could take three successive leaps over as many lances, placed parallel to each other, at different distances.

The Guayres or Councillors of the Canaries were chosen from amongst the most noble and brave. The names of some of these have been preserved, and their actions recorded. Of one of them, Adorgama, it is said, "This Canarian Hercules brought down, with a single throw of a stone, a palm-branch, which he had taken for his aim, on one of the loftiest date trees. It is well known, that their strong large leaves are capable of resisting the stroke of an axe. He could wrestle for two hours together without taking rest; and no one was found able, with both hands, to prevent him from carrying a vessel filled with water to his lips, without spilling a drop, or cause his hands to shake whilst he was drinking. In a single combat with one of the most valorous warriors of Telde, he happened to fall under his antagonist; but he, at the same time, compressed him so forcibly in his arms, that his bones broke, and he was obliged to beg for quarter. This powerful athlete was taken prisoner, after having his thigh run through with a spear, by the General Juan Rejon. He was sent to Seville with other prisoners, where his extraordinary strength was the admiration of the Spaniards."

Mummies.

The Guanchees had the art of embalming, and their mummies were prepared in a manner somewhat similar to that of the Egyptians. Some were placed in coffins, others were wrapped in sheeps' and goats' skins. They were placed in caverns in almost inaccessible situations; some in erect posture, others reclining. Mention is made of one of an aged woman, which was placed in a bent position, with her knees drawn up, like those of Peruvian mummies. The mummies of the Guanchees exhibited considerable differences as to the care and expense bestowed in their preparation, both as to the character of the covering, which was sometimes raw, at other times tanned; sometimes single, and at other times extending to six envelops, sown together with admirable workmanship.

Having some very intelligent friends residing in the Canaries for the benefit of their health, I took advantage of the opportunity to correspond with them on the subject of the ancient inhabitants of those islands. They found that the traces of their former existence were, to a great degree, obliterated; and of the mummies, formerly so numerous, not a single specimen was to be obtained.

My friend C. Smith, however, kindly exerted himself, and succeeded in obtaining portions of three or four skeletons. All of these, even granting that they belong to individuals of the female sex—which was probably the case—are evidently the remains of individuals of small stature.

As I had hitherto merely observed, without measuring, I was desirous of putting the question to the test of actual measurement, and I was pleased to find that this could be applied to a considerable number of specimens. The result of this inquiry I shall now offer in a tabular form. As there has been no picking and selection in bringing together these data, it may very fairly be supposed that they will furnish a tolerably accurate idea of the average dimensions of the race to which they belong.

A male Guanche in the College of Surgeons.

	Feet.	Inches.	
Height, ...	4	10	
Breadth of os frontis, . .	0	4½	
Arm, ...	2	2¼	
Radius, ...	0	8¼	
Femur, ...	0	15	
Guanche, ...	4	6·3	Garden of Plants.
Do. male, ...	4	10·6	do.
Do. female, ...	4	7	do.

	Inches.	
Femora of different Guanches, .	14⅜ 14¼	Sent to Dr H. from Teneriffe.
Part of a small Cranium, . .	15⅛	

A small Cranium, Dr More's collection.
Radius and hand, larger size, do.
Entire body, dried, weighing only 7½ lb.—Blumenbach.

Measurement of Ossa Femoris, not Guanche:

		Inches.			Inches.
Littlejohn, .		22		Coll. Surg.	17⅛
O'Brien,	Coll. Surg.	22 and a fraction.		do.	17⅛
				do.	17¼
	do.	22	Small, .	do.	15⅞
	do.	19	A Peruvian,	do.	15⅛
	do.	18			

The result of this investigation has rather tended to confirm my previous impression that, in former times, a small race of men existed in the Canary Islands; and as there is, at the same time, no reason to doubt the general accuracy of those authors who wrote from personal observation, and whose statements bear out the description adopted by Dr Prichard and Sabin Berthelot, it becomes a matter of curious ethnological speculation and inquiry, how these conflicting evidences are to be reconciled. That which suggests itself as the most plausible is, that the Canary Islands have, at different epochs, been occupied by tribes or nations of men presenting different physical characters. So far from there being any thing extraordinary in such succession, it is known to have taken place in several other parts of the globe. The numerous sepulchral mounds and tumuli, and other remains, extensively, if not numerously, spread over the northern portion of the Old Continent, attest the former existence of a race differing in their physical as well as their social character and degree of civilization from the population now possessing the same territory, and even from those whom history, in some instances, teaches us to have more recently preceded the existing stock. The parallel case which I have just suggested with respect to the Canary Islands, is only offered as a conjecture tending to the removal of an apparent difficulty; and I am aware that it must be by no means easy to apply any test by which to confirm or weaken its probability.

The vocabulary of the language spoken by the inhabitants of the Canaries at the time of the conquest, so far as it has been preserved, indicates that this people were closely connected with the Berbers; and several points of resemblance, both in disposition and customs, have been pointed out in confirmation of this received connection. In addition to the points of correspondence, it would be desirable to discover and indicate those of difference. So far as I am aware, the Berbers were not in the habit of embalming their dead. We may, therefore, not unreasonably suspect that the Berbers who passed over to the Canary Islands did not take this practice with them, but rather adopted it from another people who preceded them, and whose process of embalming, whilst strikingly resembling that of the ancient Egyptians, was yet accompanied with the same particulars, indicative of a no less remarkable difference, which makes the Guanchee mummies hold a character intermediate between those of Egypt and those of Peru. It is rather remarkable that there had apparently been a falling off in the art of making mummies, and that a practice of inferior character was in use at the time when the island became known to the Spaniards. The state of civilization seems likewise to have been of rather an anomalous character. Temples, houses, progress in some of the arts, and the state of society divided into classes, seem to be the token of advanced civilization with which the semibarbarous character observable in other particulars, is strangely contrasted. I may mention, more especially, the practice of going in a state almost approaching to nudity, which appears to have been very common. The girdle, forming a deep fringe of numerous threads, constituted a garment altogether characteristic of savage life. I regret that I do not at present see any clew to the satisfactory solution of the question; but whilst the philologist may possibly detect in the vocabulary of the Guanchees words so distinct from those of the Berbers as to indicate that mixture of different races had at one time taken place, the careful examination of the few relics which have been preserved, and more especially of the mummies which are to be found in many collections, may admit a ray of light where none at present is to be seen. A careful investigation of the original sources of information would, in this, as well as in many other ethnological inquiries, be very important.

PHILOLOGICAL COMMENTS BY DR LATHAM.

Such evidences respecting the origin of the Guanchees as was to be drawn from their language, was known to the early Spanish historian of the Canary Isles, and to his English translator, Glas. It was also known that the language of the islands of Fortaventura, Lanceroto, Ferro, Palma, and Gomera, were akin to the Canary Proper. The Teneriffe language, however, was made an exception. This was stated to stand alone. The six others were compared with one of the languages of Northern Africa, viz., the Shillah dialect of the Berber; and with this they were found to coincide to the amount of about twenty words out of eighty, or one-fourth. Since then the affinities between the Guanche languages on one side, and the Berber on the other has been recognised by Hornemann, Adelung, Ritter, Prichard. Quite lately, however, the author of a paper in the Journal of the Geographical Transactions has demurred to the received opinions. He brings much evidence to prove that the languages of the different islands were mutually unintelligible. He also objects to treating the six languages as one, and making the comparison with them *en masse*.

Now languages may be mutually unintelligible and yet have a close ethnographical relationship; as is the case with the English and German, the Dutch and Danish, &c. On the other hand, the comparison of languages in groups is one of the most legitimate processes in philology. Hence it is with great truth that the editor of the journal in question dissents, in a note appended to the article, from the objections of the writer.

The Berber language is the language of the whole of Northern Africa with the exception of the Arabic. It is spoken on the coast of the Atlantic, and on the confines of Egypt; in the Oasis of Siwah, in Fezzan, Tunis, Tripoli, Algiers, and Morocco; and it is known under the various names of Showiyah, Amazirgh, Shillah, and Ertana. It is the mother-tongue of the Algerine Cabyles, and of the Tuaricks of Sahara. It was the ancient language of Numidia and Mauritania; and was probably spoken in its older stages, by Jugurtha and Masinissa.

Of late years it has justly been looked upon as one of the most important languages in Ethnography.

Such is the family to which the languages of six out of seven of the Canary Islands belong.

The isolation of the Teneriffe tongue is rather apparent than real. Of its vocabulary we have but thirty-nine words; of which only fifteen are the names of common objects.

English	cloak
Teneriffe	ahico
Shillah	tahayck

English	butter
Teneriffe	oche
Ferro	aculan

English	milk
Teneriffe	ahof
Canary	aho
Lancerota	aho
Shillah	agho

English	goat
Teneriffe	ara
Canary	aridaman

English	knife or sharp stone
Teneriffe	tavonas
Lancerota	taffiaque

English	God
Teneriffe	guarirari
. . .	aquayareran
Canary	gayres—senator
Shillah	rugan—ruler

The general affinities of the Guanchee or Canary languages (the Teneriffe being included) are, of course, those of the Berber tongues in general.

Respecting these the present writer unwillingly differs from several distinguished philologists. It is not his opinion that the Berber tongues have a place with the Hebrew, Syriac, Arabic, and Æthiopic languages, in the great Semitic class. He inclined to connect it rather with the true Negro languages, (or the African Proper); although his *data* for so doing are deficient in fulness and definitude. Finally, he believes that the Tibboo language has been improperly connected with the Berber tongues, and consequently, through them, with the Guanche.

The word *Facgan* = *priest*, if connected with the Arabic *Fakir*, is remarkable; inasmuch as it indicates the probability of the population of the Canary Isle having left the Continent of Africa subsequent to the Mahommedan conquest.

Over and above the regular vocabulary of Glas, isolated words (such as the name of the various kinds of fish) are to be found in his work. The numerals, moreover, and a few other words, occur, from other miscellaneous sources, in the paper of the Geographical Transactions.

On Lunar Periodicities in Earthquakes, and remarkable Atmospherical Phenomena. By RICHARD EDMONDS jun., Esq. Communicated by the Author.

In a paper, of which an abstract appeared in the Number of this Journal for April (p. 271), I have noticed some very striking instances of lunar periodicities in earthquakes, extraordinary oscillations of the sea, and great atmospherical changes. The last few months have furnished me with additional examples. The remarkable *maxima* of the barometer which are noticed in the following table, occurred at successive intervals of single lunations—the principal ones being on the 21st of December and the 21st of March :—

	Barometer at Chiswick.	Higher than for		REMARKS.
		days before.	days after.	
1844.				
Nov. 21.	30·304	52	6	Warmest day of the month in Cornwall.*
Dec. 21.	30·462	234	90	Coldest night of the year in Cornwall.
1845.				
Jan. 21.	30·210	13	21	
Feb. 20.	30·164	7	14	
March 21.	30·495	357	above 130	The driest as well as the warmest day of February in Cornwall was the 21st, when a smart shock was felt in Alexandria.†

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* At Pençarrow, near Bodmin. Monthly Agricultural Report for Cornwall, published in the *West Briton.*

† Almost exactly four lunations after this shock at Alexandria, when the English ship Victory was in the Mediterranean, in lat. 36° 40′, long. 13° 44′, "her top-gallant masts and royal mast went suddenly over the side, as if by a sudden heavy squall, though there was not at the time the least appearance of a squall." Two hours afterwards three immense balls of fire rose from the sea, and remained visible for about ten minutes. This happened on the evening of the 18th of June. On the same evening, from Mount Lebanon were seen, for an hour, two very bright meteors moving towards the east, and connected with each other by streams of light—each meteor being apparently five times larger than the full moon, which had just risen.

Another series of remarkable states of the atmosphere, with similar intervals, will be found in connection with the earthquakes in Huntingdon, on the 26th of March last:—

1845.

Jan. 28. Barometer at Chiswick 28·932; lower than for 79 days before and ever since.

Feb. 26. Thermometer at Chiswick 52°; higher than for 31 days before and 25 days after.

March 26. Shock of earthquake this evening at Huntingdon,* &c.

April 25. Barometer at Penzance this evening lower than for 15 days before and 40 days after.

May 25. About 2 o'clock A.M., at Penzance, a severe thunder-storm, with unusually heavy rain. In the afternoon "a terrible shower of hail desolated several communes of the provinces of Brabant,—the hailstones were of enormous size."

Here I may add, that, on the 19th August, which is about three lunations after this dreadful hail-storm, a most awful whirlwind visited the neighbourhood of Rouen. "Houses, trees, and crops were swept away, and so mingled, that of some buildings it was impossible to trace the site. Three large factories were hurled down," and a great many persons perished.

The 20th of August was predicted by M. Arago to be the commencement of a long period of fine weather, which has since occurred.

So, also, before and after the great earthquake in Mexico, on the 7th of April last, there were other earthquakes and remarkable atmospherical phenomena, at intervals of about single lunations, and near the times of new moon:—

1845.

March 9. Earthquakes throughout Mexico, and at Campsie near Glasgow.† Singular appearance of the sun observed at Cambridge,‡ within two hours after the shock near Glasgow. The driest day of the month in Cornwall. M. Arago predicted that on the 8th of March (new moon) the Seine would be frozen over, which has proved correct.

April 7. Another earthquake throughout Mexico, severer than any experienced there before for above a century. Shock also felt at sea near the equator, in long. W. 27° 17′. The air in Cornwall drier, by many degrees, than on any other day of the year up to August.

May 8. Barometer at Penzance lower than for 11 days before and 26 days after. At Chiswick it was 29·407; lower than for 23 days before and 25 days after.

June 5. A violent storm at Penzance from SW.—Barometer there this evening lower than for 56 days before and 22 days after.

July 5. Barometer at Penzance higher than for 11 days before and 9 days after,—the maximum at Chiswick being 30·196; higher than for 24 days before and above 26 days after. Dreadful thunder-storm in Berkshire, Hampshire, and other counties, on the 3d; and another on the 6th, in Worcestershire, &c., accompanied by a most destructive whirlwind, which "picked up a small boat out of the Severn, and left it on dry ground at some distance from the river's bank." The new moon was on the 4th.

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* See *Cambridge Chronicle.* † *Glasgow Argus* of 17th March.

‡ *Literary Gazette* of 22d March, p. 186.

1845.

August 2. Another whirlwind near Lowestoft, in Norfolk,* this afternoon, and thunder-storm in London. Throughout the preceding day a very heavy fall of rain at Penzance, commencing with a shower of hail—a most extraordinary circumstance at this period of the year.

30. Barometer at Penzance higher than for 81 days before. The following day was the warmest, and also the driest, of the month in Cornwall.

The following seven remarkable days occurred at or near successive first quarters of the moon:—

1844.

Dec. 16. Moon's first quarter. Barometer at Chiswick 29·316; lower than for 36 days before, and 34 days afterwards.

1845.

Jan. 15. Smart shock of earthquake at St Malo.† On the preceding night, a hurricane in the Mediterranean. On the following morning (the 16th), a "terrific" luminous meteor seen at Cette during bright sunshine.

Feb. 12. The greatest cold experienced in England probably during the present century. Thermometer at Blackheath, at half-past 7 A.M., 33¼° below the freezing point; at Chiswick, 35° below that point. Barometer at the latter place 30·409; higher than for nine months before, except on the 21st of December, noticed in the beginning of this paper.

Mar. 13, 14. Thermometer at Penzance, this night, 16°; lower probably than for many years. Barometer at Chiswick on the 16th (the moon's first quarter), 29·500; lower than on any other day of this or the preceding month.

April 14. This night, until the following evening, it blew at Penzance almost a hurricane from the north; the barometer all the time rising steadily and rapidly. It was also a boisterous day at Chiswick.

May 14. Moon's first quarter. Barometer at Chiswick 30·302; higher than for 27 days before, and 25 days after.

June 13. Extraordinary oscillation of the sea and whirlwind at Folkstone,‡ in Kent; and a terrific thunder storm at Chatham. Thermometer at Penzance higher than on any other day of the year up to September, it being also very high in all parts of England.

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* *Norfolk Chronicle* of 9th August, from which it appears that the violence of the whirlwind was such as to dismast vessels, lift boats out of the water, and blow others, lying on the land, to considerable distances. The spray from the river was raised twenty yards high; and several swallows and sparrows were dashed to the ground, and either killed or stunned, so as to be easily taken.

† This, and several other facts noticed in this paper, were derived from the newspapers.

‡ It was observed at 4 o'clock, P.M. "The tide, then flowing, changed to ebbing three different and continuous times, causing much

This 13th of June is the last of a series of nine remarkable days (which I have elsewhere described*), separated by intervals of about four lunations, each day being distinguished by an earthquake, an extraordinary oscillation of the sea, or some very unusual state of the atmosphere; and each of the phenomena being within forty-eight hours of the moon's first quarter. Three† of the days were each at the moon's first quarter nearest the solstice, and were remarkable for great thunder-storms, while the first and last of these three days were distinguished also by extraordinary oscillations of the sea.

In reference to the six known‡ shocks of the earth, and extraordinary oscillations of the sea, in Cornwall, during the last century, I may here remark, that the interval between any two of them is almost exactly some multiple of a lunation. The same observation applies to the six which have occurred in the present century, except that of the 20th October 1837; with this single exception, all have happened at or near the moon's first quarters.

From the facts above noticed, it would appear that an earthquake, or any very disturbed or extraordinary state of the atmosphere, is usually preceded or followed by other earthquakes or extraordinary states of the atmosphere, occurring at intervals of single lunations, or of multiples of a lunation; and that the phenomena which happen at intervals of four lunations are generally more striking than those which occur at shorter periods.

PENZANCE, *2d September* 1845.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *The Temperature of Rain-Drops.*—On the temperature of the drops of rain in Cumana, which falls to 22·3° C. (72·1° F.), when the temperature of the air shortly before had been 30°–31° C. (86°–87·8° F.), and sinks during the rain to 23·4° C. (75·1° F.), *vide* my Relat. Hist., t. ii., p. 22.—The rain-drops, as they fall,

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agitation at the harbour's mouth. This had been preceded by a heavy and brief whirlwind from the SE. The rise of the water appeared to be about three feet, and its sudden receding produced the agitation."

* In a paper on this subject read at the British Association meeting in 1845.

† 5th of July 1843, 23d of June 1844, and 13th June 1845.

‡ The dates are given in the Trans. of the Geol. Soc. of Corn., 1843, p. 111, and 1844, p. 209.

change the temperature they had on their production, which depends on the height of the clouds whence they come, and the heating of these on their upper surface by the sun's rays. After the rain-drops, on their first formation, by reason of the latent caloric of the vapour becoming sensible, have acquired a higher temperature than the surrounding medium, they still rise somewhat in temperature; whilst, as they fall through lower, warmer, and moister strata of air, vapour continues to be precipitated upon them, and they increase in size (Bischof, Wärmelehre, S. 73); but this rise is compensated by evaporation. Cooling of the air by rain is effected (setting aside what probably belongs to the electrical processes attending thunder-storms) by the drops, which are themselves of lower temperature, in consequence of the place of their formation, and, farther, bring down a portion of the higher colder air; and then by moistening the ground, and giving occasion to evaporation. Such are the usual relations of the phenomenon. When, in rare cases, the rain-drops are warmer than the lower strata of the atmosphere (Humboldt, Relat. Hist., t. iii., p. 513), the reason may perhaps be sought for in superior warmer currents, or in a higher temperature acquired by extended and not very dense clouds, exposed to the action of the sun's rays. How, for the rest, the phenomena of supplementary rainbows (explained by the interferences of light) are connected with the size of the falling drops and their increase; and how an optical phenomenon, when rightly observed, may enlighten us in regard to a meteorological process, according to diversity of zone, has been shewn, with great acuteness, by Arago, in the Annuaire for 1836, p. 300.—*Cosmos*, No. 4, p. 443.

2. *On the Height of the Snow-Line in India.*—Whilst the most learned and experienced travellers in India,—Colebrooke, Webb, Hodgson, Victor Jacquemont, Forbes Royle, C. Von Hügel, and Vigne, who are all familiar with the Himalaya, from personal examination, are agreed as to the higher elevation of the snow-limit on the Thibetic declivities of the range, the fact is called in question by Gerard, M'Clelland (the editor of the Calcutta Journal), and Lieut. Thomas Hutton (assistant surveyor of the Agra division). The appearance of my work on Central Asia excited the controversy on the subject anew. A number of M'Clelland and Griffith's Calcutta Journal of Natural History, vol. iv., 1844, January, however, contains a very remarkable and decisive notice of the snow-limit of the Himalaya. Mr Batten (Bengal service), writes from the camp of Semulka, on the Cosillah river, in the province of Kumaon, as follows:—"I have only, but with surprise, heard of the statements of Mr Thomas Hutton, respecting the limits of perpetual snow. I feel the more called upon to contradict such statements, as Mr M'Clelland goes so far as to speak (Hutton, Journal of the Asiatic Society of Bengal, vol. ix., Calcutta, 1840, p. 575, 578, and 580), of the honour which Mr Hutton has done himself in detecting a wide-spread error. It is

very erroneously stated, that every one who ascends the Himalaya must share in Mr Hutton's doubts. I am myself one of those who have visited the western portion of our mighty mountain chain most frequently. I came through the Borendo pass into the Buspa valley, and the inferior Kunawur-land, returning through the lofty Rupin pass into the Rewaian mountains of Gurwal. I penetrated to the springs of the Jumna, as far as Jumnotri, and then turned to the tributaries of the Ganges of Mundakni and Wischnu-Aluknunda, towards Kadarnath, and the celebrated snowy summit of Nundidevi. I several times crossed over the Niti pass to the high lands of Thibet. I myself founded the settlement of Bhote-Mehals. My continued residence of six years among the mountains brought me into contact with many native and European travellers, from whom I could obtain the most accurate information concerning the country. From all my experience gathered in this way, I have arrived at the conclusion, and am ready to maintain it, that in the Himalaya the limit of eternal snow lies higher on the northern, or Thibetic, than on the southern, or Indian declivities. Mr Hutton alters the terms of the proposition, when he thinks he disproves Humboldt's general view of the phenomenon; he fights against a creation of his own fancy, when he seeks to prove, that in some single mountains of the Himalaya the snow lies longer on the northern than on the southern slopes; a proposition which we readily grant him." *Vide* also Note 5 (Notes, p. 45). If the mean height of the Thibetic high lands be 10,800 feet, they may then be compared with the delightful and fertile Peruvian plateau of Caxamarca. But on this estimate still they would be 1200 feet lower than the plateau of Bolivia, the lake of Titicaca, and the causeway of the town of Potosi. Ladak, from Vigne's measurement by the boiling point of water, is 1563 toises high. This is probably also the height of H'Lassa (Yul-jung), a town of monks, which Chinese writers speak of as the "realm of pleasure," and which is surrounded by vineyards. Must not these lie in deeply cut valleys? —*Cosmos*, No. 4, p. 473. *By Alexander Von Humboldt.*

3. *A Violent Hail Storm.*—September 16th.—To the seventh posta at the foot of the Sierra Tapalguen. The country was quite level, with a coarse herbage and a soft peaty soil. The hovel here was remarkably neat, the posts and rafters being made of about a dozen dry thistle stalks bound together with thongs of hide; and by the support of these Ionic-like columns, the roof and sides were thatched with reeds. We were here told a fact, which I could not have credited, if I had not had partly ocular proof of it; namely, that, during the previous night, hail as large as small apples, and extremely hard, had fallen with such violence as to kill the greater number of the wild animals. One of the men had already found thirteen deer (*Cervus campestris*) lying dead, and I saw their *fresh* hides. Another of the party, a few minutes after my arrival, brought in seven more. Now, I well know that one man without dogs could hardly have killed

seven deer in a week. The men believed they had seen about fifteen dead ostriches (part of one of which we had for dinner); and they said that several were running about evidently blind in one eye. Numbers of smaller birds, as ducks, hawks, and partridges, were killed. I saw one of the latter with a black mark on its back, as if it had been struck with a paving-stone. A fence of thistle-stalks round the hovel was nearly broken down; and my informer putting his head out to see what was the matter, received a severe cut, and now wore a bandage. The storm was said to have been of limited extent: we certainly saw from our last night's bivouac a dense cloud and lightning in this direction. It is marvellous how such strong animals as deer could thus have been killed; but I have no doubt, from the evidence I have given, that the story is not in the least exaggerated. I am glad, however, to have its credibility supported by the Jesuit, Drobrizhoffer,[*] who, speaking of a country much to the northward, says, "Hail fell of an enormous size, and killed vast numbers of cattle: the Indians hence called the place *Lalegraicavalca*, meaning 'the little white things.'" Dr Malcolmson, also, informs me that he witnessed in 1831, in India, a hail-storm, which killed numbers of large birds, and much injured the cattle. These hail-stones were flat, and one was ten inches in circumference, and another weighed two ounces. They ploughed up a gravel walk like musket-balls, and passed through glass windows, making round holes, but not cracking them.—*Darwin's Journal of a Voyage Round the World*, part i., p. 115.

4. *The Effects of Great Droughts.*—While travelling through the country, I received several vivid descriptions of the effects of a late great drought; and the account of this may throw some light on the cases where vast numbers of animals of all kinds have been embedded together. The period included between the years 1827 and 1830 is called the "gran seco," or the great drought. During this time so little rain fell, that the vegetation, even to the thistles, failed; the brooks were dried up, and the whole country assumed the appearance of a dusty high-road. This was especially the case in the northern part of the province of Buenos Ayres, and the southern part of St Fé. Very great numbers of birds, wild animals, cattle, and horses, perished, from the want of food and water. A man told me that the deer[†] used to come into his courtyard to

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[*] History of the Abipones, vol. 2., p. 6.

[†] In Capt. Owen's Voyage (vol. ii., p. 274) there is a curious account of the effects of a drought on the elephants, at Benguela (west coast of Africa). "A number of these animals had some time since entered the town, in a body, to possess themselves of the wells, not being able to procure any water in the country. The inhabitants mustered, when a desperate conflict ensued, which terminated in the ultimate discomfiture of the invaders, but not until they had killed one man, and wounded several others. The town is said to have a population of nearly three

the well, which he had been obliged to dig to supply his own family with water; and that the partridges had hardly strength to fly when pursued. The lowest estimation of the loss of cattle, in the province of Buenos Ayres alone, was taken at one million head. A proprietor at San Pedro had, previously to these years, 20,000 cattle; at the end not one remained. San Pedro is situated in the middle of the finest country, and even now abounds again with animals; yet, during the latter part of the "gran seco," live cattle were brought in vessels for the consumption of the inhabitants. The animals roamed from their estancias, and, wandering far southward, were mingled together in such multitudes, that a Government commission was sent from Buenos Ayres to settle the disputes of the owners. Sir Woodbine Parish informed me of another and very curious source of dispute: the ground being so long dry, such quantities of dust were blown about, that in this open country the landmarks became obliterated, and people could not tell the limits of their estates.

I was informed by an eye-witness that the cattle, in herds of thousands, rushed into the Parana, and being exhausted by hunger they were unable to crawl up the muddy banks, and thus were drowned. The arm of the river which runs by San Pedro was so full of putrid carcasses, that the master of a vessel told me that the smell rendered it quite impassable. Without doubt several hundred thousand animals thus perished in the river; their bodies, when putrid, were seen floating down the stream; and many in all probability were deposited in the estuary of the Plata. All the small rivers became highly saline, and this caused the death of vast numbers in particular spots; for when an animal drinks of such water it does not recover. Azara describes* the fury of the wild horses on a similar occasion, rushing into the marshes, those which arrived first being overwhelmed and crushed by those which followed. He adds that more than once he has seen the carcasses of upwards of a thousand wild horses thus destroyed. I noticed that the smaller streams in the Pampas were paved with a breccia of bones, but this probably is the effect of a gradual increase, rather than of the destruction at any one period. Subsequently to the drought of 1827 to 1832, a very rainy season followed, which caused great floods. Hence, it is almost certain that some thousands of the skeletons were buried by the deposits of the very next year. What would be the opinion of a geologist, viewing such an enormous collection of bones, of all kinds of animals and of all ages, thus embedded in one thick earthy mass? Would he not attribute it to a flood having swept over the surface of the land,

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thousand. Dr Malcolmson informs me, that, during a great drought in India, the wild animals entered the tents of some troops at Ellore, and that a hare drank out of a vessel held by the adjutant of the regiment.

* Travels, vol. i., p. 374.

rather than to the common order of things?*—*Darwin's Journal of a Voyage Round the World*, part i., p. 132.

5. *Formation of Clouds.*—In an article, vol. xxxviii., page 50 of this Journal, I endeavoured to shew that the phenomena of the ascent of vapour, and its suspension in the region of the clouds, cannot be accounted for by the agency of heat; that the vapour in the region of the clouds is at all times condensed; and that "the formation of clouds is, in general, not owing to the sudden condensation of the vapour, but to the escape of its electricity, thus allowing the particles to be brought nearer by the attraction of aggregation; and a still farther escape of the electricity enables such attraction to overcome the electrical repulsion of the particles, and to form rain."

The opinions advanced by Sir John Herschel (at the Cambridge meeting of the British Association), on the effect of the heat of the moon in dissipating clouds, tell against this theory; and, although the opinion of that eminent philosopher must have great weight, I trust I may not be thought presumptuous in endeavouring to shew that it cannot be the *heat* of the moon that causes the phenomenon alluded to in the following extract.

"Speaking of the climate of the moon, Sir J. Herschel considered as possible the attainment of a very high temperature (far above that of boiling water), by its surface, after exposure to unmitigated and continual sunshine during nearly a whole fortnight. The moon, therefore, when at the full, and for a few days after, must be, in some small degree, a source of heat to the earth; but this heat, being of the nature of culinary rather than of solar heat (as emanating from a body below the temperature of ignition), will never reach the earth's surface, being arrested and absorbed in the upper strata of an atmosphere where its whole effects will necessarily be expended in the conversion of visible cloud into transparent vapour. The phenomenon of the rapid dissipation of clouds (in moderate weather) soon after the appearance of the full moon (or of a moon so nearly full as to appear round to the unassisted eye), which he stated himself to have observed on so many occasions as to be fully convinced of the reality of a *strong tendency in that direction*, seem to him explicable only on this principle."—*Athenæum*, July 19, p. 722.

In the first place, it is very doubtful whether the moon does absorb heat sufficient to raise its temperature to such a degree; for as the rays of a tropical sun are insufficient to melt the snow on the higher mountains where the air is rarified, the fortnight's action of the sun may have little influence on the surface of the moon, where, according to the opinions of many, there is no atmosphere.

Secondly, if the moon does absorb heat, and its temperature is raised as Sir J. Herschel supposes, the heat that would arrive at the earth, or its atmosphere, would be very trifling; for if the heat of the moon be sufficient to raise the temperature to the boiling point (212°), *at* 100 *miles distance from its surface*, even then it could not increase the temperature at the distance of the earth so much as the $\frac{1}{300}$ part of a degree, which is so trifling, that if the nights about the time of the full moon are clearer than those of the other parts of the lunar month, I submit that it must be caused by some other agency than the *heat* of the moon; and it is difficult to conceive how the little heat we receive from the moon can disperse clouds, while the direct action of the sun is insufficient to do so.—(*Communicated by G. A. Rowell, Esq., Oxford, Sept.* 9. 1845.)

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* These droughts, to a certain degree, seem to be almost periodical. I was told the dates of several others, and the intervals were about fifteen years.

GEOLOGY.

6. *Gas Springs in the river Wear, county of Durham.*—The river Wear, immediately above and below Framwellgate Bridge, Durham, now presents a singular appearance, as, when unruffled by the wind, it appears to be in a state of ebullition, occasioned by numerous streams of air-bubbles issuing from below. On one of the largest of these, Mr Wharton of Dryburn made some experiments, the result of which is, that a large and brilliant jet of flame, arising, as it were, from the river, can now be produced at pleasure. The stream of gas appropriated to the above experiment is one only of a great many others which occupy an area of from 50 to 100 square yards of water, and which must, together, discharge very many gallons of gas per minute. The distance of the extreme clusters, being upwards of 100 yards, furnishes a strong presumption that the source of this extraordinary discharge of gas is situated at a great depth below the bed of the river. No coal workings are known to exist within several hundred yards of the bridge. It must, therefore, in all probability, be traced to one of those extensive natural accumulations of gas lurking in the fissures and pores of the strata far below the surface of the ground, which, when tapped by the operations, and fired by the candles of the miner, have been the frequent causes of those dreadful explosions, of one of which the working of Haswell Colliery bore such awful testimony last year. It has been proposed to light the bridge from this source, and other parts of the town, if there appears a probability of its continuance. Many persons assert that they have noticed bubbles rising from the water for eighteen months or two years past, and as the remarkable emission of hydrogen from one of the old shafts of Wallsend Colliery has been burning for many years, and is giving a clear light, which is visible at night for miles, it is probable this natural supply on the Wear may last for years.

7. *Kenawha Gas.*—Communicated by Mr James A. Lewis, of Kenawha, C.H., Va., being an abstract, somewhat abridged, from the Charleston Republican.

The existence of large quantities of gas at various points throughout the whole extent of the salt region on the Kenawha river, was known to the first White men that explored this beautiful valley. It appeared escaping through apertures in low grounds, and springs of water. As a company of the earliest explorers encamped on the banks of the river, one of their number, in a dark night, took a torch to light his way to the spring near by the encampment, and in waving it over the spring, to his great consternation it took fire, the gas burning upon the surface of the water. It was thence called the "Burning Spring," and is the same that is mentioned by Mr Jefferson in his Notes on Virginia. It is still there, but, as we saw it last week, a mere mud-puddle. The water agitated by the gas resembles a boiling pot. It readily ignites, and for a short time it burns with a blue blaze on the surface of the water; even when the water is dried up, the gas will burn brilliantly between one rain and another.

When, in process of time, the salt-manufacturers, either from a failure of the salt water above the stratum of rock, some 15 or 20 feet lower than the bed of the river, or for the purpose of procuring the water in greater abundance, sunk their wells by boring far below the surface of the rock, the gas, in various quantities, made its appearance in the wells, in some instances jetting the water into the air, when being ignited, it spread the flame about, to the no small amazement and terror of the workmen. When this happened, they used to say "*the well is blowed.*" The stream of gas, however, soon subsided, or acted only with sufficient power to force the water up into the gum or shaft, which is part of the trunk of a sycamore tree, about four feet in diameter, hollowed out so that the shell is not more than 4 inches thick. From the gum it was pumped into the cistern or reservoir.

Our salt wells are commenced near the edge of the river at low water. The gum is sunk down to the rock, a distance of from 15 to 20 feet, the lower end resting tightly on the rock. The other end is usually a few feet above the ground. This excludes the fresh water above the rock, and serves as a reservoir to receive the salt water, when it is reached by boring through the rock and the various strata of earth.

Three years ago, William Tompkins, Esq., first obtained a steady and permanent stream of gas, of sufficient power, not only to force the water up from the depth of a thousand feet into the gum, but to carry it into the reservoir elevated many feet above the bank of the river. This saved the expense of a pump, which is worked by a steam-engine. In a short time, it occurred to him, that this gas could be turned to a still more useful purpose. He therefore erected, over the reservoir or cistern, a gasometer, which is simply a hogshead, placed upright, in the lower end of which is inserted the pipe that conveys the water and the gas from the wells, the water running out through a hole in the lower end, and in the top is inserted a pipe that conveys the gas to the mouth of the furnace. When ignited, it produces a dense and intensely heated flame along the whole furnace under the row of kettles, 100 feet long, by 6 deep, and 4 wide. This saves the expense of digging and hauling coal.

Subsequently, Messrs Warth and English, whose works are on the opposite side of the river, obtained a similar stream of gas, which has been used successfully in the same way; and more recently Mr Dryden Donnally, Mr Charles Reynolds, and some few others, produced a partial supply of gas to heat their furnaces in the same way.

But the most remarkable phenomenon in the way of natural gas here, and we have, no doubt, in the whole world, is that at the works of Messrs Dickinson and Shrewsbury, which has been exhibited for nearly two months past. In this well the gas was reached at the depth of one thousand feet. What the upward pressure of the gas to the square inch is, through the aperture, which is three inches in diameter, we are unable to tell; and, perhaps, it would be impossible to ascertain. It has never had a free and unobstructed vent. There is now, at the bottom of the well, an iron sinker, a long piece of round iron nearly filling the aperture; on this are 600 pounds of iron, and about 300 feet of auger-pole used in boring, in pieces of 10 and 20 feet in length, with heavy iron ferules on the end, screwed into each other. Notwithstanding all this obstruction, a stream of water and gas issues up through a copper tube, 3 inches in diameter, inserted into the well to the depth of 500 feet, with the noise and force of steam generated by the boilers of the largest class of steam-boats. It is computed that a sufficient quantity of gas comes from this well to fill, in five minutes, a reservoir large enough to light the city of New York during twelve hours. When we reflect that this stream of gas has flowed, unabated, for nearly two months, what must be thought of the quantity and the facility of manufacturing it down below! In the springs hard by, and in the other wells (with perhaps the exception of that of one or two others), there appears, as yet, to be no diminution in the quantity at any place where it has heretofore been known to exist.—*American Journal of Science and Art*, vol. xlix., No. i., p. 209.

8. *Geological Survey of Canada.*—A bill has just passed the House of Assembly of Canada, making provision for a geological survey of the province. A sum, not exceeding L.2000, is to be appropriated annually for five years; and such a number of persons selected for the work as shall be necessary to make an accurate and complete geological survey.—*Christian Guardian for February* 26, 1845, *Toronto, Canada.*

9. *On the known Thickness of the Crust of the Earth.*—It is proper to distinguish between the *absolute* depth to which man has penetrated in his mining operations, or the depth from the surface of the earth at the place where the operations are carried on, and the *relative*

depth, *i. e.*, the depth below the level of the sea. The greatest relative depth that has been reached is, perhaps, the bore at New Salzwerk, Minden, in Prussia. In June 1844, it was exactly 1844½ Parisian feet; the absolute depth was, however, 2094½ Par. feet. The temperature of the water in the deepest bore was 32·7° C. (90·8° F.) which, assuming 9·6° C. as the mean temperature of the air, gives a rise of 1·6° for 29·6 metres (upwards of 97·6 feet English). The Artesian well of Grenelle, at Paris, is only 1683 feet in absolute depth. From the accounts of the missionary Imbert from China, the depth of our Artesian wells is far surpassed by that of the fire-spring, Ho-tsing, which yields inflammable gas, employed in salt boiling. In the Chinese province Szü-tschuan, these fire-springs are said very commonly to reach a depth of from 1800 to 2000 feet; and at Tseu-lieu-tsing (place of perpetual flux) a Ho-tsing bored with the rod in the year 1812, is reported to extend to the depth of 3000 feet (Humboldt, Asie Centrale, t. ii., p. 521 and 525; Annales de l'Association de la Propagation de la Foi, 1829, No. 16, p. 369.) The relative depth attained at Monte Massi, in Tuscany, south from Volterra, according to Matteucci, is about 1175 feet. The bore at New Salzwerk approaches very nearly in relative depth the coal pit at Apendale, Newcastle-under-Lyme (Staffordshire). There the works are carried on 725 yards, or 2045 French feet, under the surface (Th. Smith, The Miner's Guide, 1836, p. 160). Unfortunately, the height of the ground above the level of the sea is not accurately ascertained. The relative depth of the Monkwearmouth pit, near Newcastle-on-Tyne, is only 1404 feet (Phillips, Philos. Mag. vol. v., 1834, p. 446); that of the Esperance pit, at Liege, 1271; and that of the lately-worked pit Marihaye, at Val St. Lambert, is 1157 feet. The greatest absolute depths to which man has penetrated are in mines that are either among lofty mountains or in mountain-valleys, so much raised above the sea level, that this has either not been reached at all, or has only been surpassed by a very small quantity.

The Eselschacht at Kuttenberg, Bohemia, before it was abandoned, had reached the enormous depth of 3545 feet (Schmidt, Berggesetze, Bd. 1, S. 32). At St Daniel, and at Geist, on the Röhrerbühel, the works, in the 16th century, were 2916 feet deep. A drawing of these workings of the year 1539 is still preserved. (Joseph Von Sperges, Tyroler Bergwerks-Geschichte, S. 121. See also Humboldt, Gutachten über Herantreibung des Meissner Stollens in die Freiberger Erzrevier, published in Herder über den jetzt begonnenen Erbstollen, 1838, S. 124). It may be imagined that information of the extraordinary depth of the workings at Röhrerbühel had reached England at an early period, for in Gilbert's work, De Magnete, I find the statement that man had penetrated from 2400 to 3000 feet into the bowels of the earth.

The absolute depth of the mines in the Saxon Erzgebirge are 1824 and 1714 feet; the relative depths of these respectively are only 626 and 260. The absolute depth of the rich workings in Joachimsthal, Bohemia, is 1919 feet; but taking the height of the surface upon Dechen's estimate at 2250 feet above the level of the sea, it is obvious that there the sea level has not even been attained. In the Harz, the workings in the Samson pit, at Andreasberg, are carried on at the absolute depth of 2062 feet. In Old Spanish America, I know of no deeper mines than those of Valenciana, near Guanaxuato, Mexico; I found the Planes de San Bernard 1582 feet deep; but this mine does not reach the level of the sea by 5592 feet. If we compare the depth of the old Kuttenberg works (a depth which exceeds the height of the Brocken, and only falls short of that of Etna by 200 feet) with the heights of the loftiest buildings that have been reared by man (the Pyramid of Cheops and the Minster at Strasburg), we find that the mines are to these in proportion of 8 to 1.

Basin-shaped curved strata, which dip down on one hand and rise at a measureable distance, although not penetrated by mines or shafts, still suffice to give us accurate information of the constitution of the crust of the earth at great depths from the surface. I have to thank the excellent geologist M. Von Dechen for the following:—He writes to me, "The depth of the coal measures at Mont St Gilles, Liege, which our friend M. Von Oeynhausen has estimated at 3650 feet below the surface, must lie at the depth of 3250 feet below the sea level, inasmuch as Mont St Gilles is certainly not 400 feet high; and the coal basin at Mons lies fully 1750 feet deeper. These depressions, however, are trifling when compared with that of the coal strata of the Saar-Revier (Saarbrücken). After repeated trials, have found that the lowest coal strata known in the country of Duttweiler near Bettingen, north-eastward from Saarlouis, dip 19,406, and 20,656 feet under the level of the sea." This conclusion exceeds by 8000 feet the estimate which I have given in the text of Cosmos for the basin of Devonian strata. These Belgian coal measures, therefore, lie as far below the level of the sea as Chimborazo rises above it, at a depth where the temperature of the earth must be 224° C. (435° F.). From the highest summit of the Himalaya to the bottom of this basin, containing vegetable remains of the primeval world, we have a perpendicular depth of 45,000 feet, *i. e.*, $\frac{1}{451}$ of the semi-diameter of the earth.

I have thought it important thus to bring together these data in relation to the absolute and relative depths that have been reached by man, a subject in connection with which many errors have been constantly committed, principally, as it seems, through faulty reductions of the measurements from one standard to another. On proceeding eastward from Jerusalem toward the Dead Sea, a prospect is gained which, according to our present hypsometrical knowledge, is unparalleled on the face of the earth. There, on approaching the chasm in which the Jordan flows, we advance, in open day, along beds of rock, which, according to Bertou's and Russegger's barometrical levellings, lie 1300 feet in perpendicular depth below the level of the Mediterranean Sea. (*Vide* Humboldt, Asie Centrale, t. ii. p. 323.)—*Cosmos*, No. iv. p. 418. *By Alex. Von Humboldt.*

10. *Supposed Volcanic Eruption.*—Our Orkney correspondent (September 6. 1845) mentions a phenomenon of rare occurrence in Britain, which has caused considerable surprise and excitement among the peaceful denizens of that remote region, and which has led to the impression that these islands have just been visited by the effects of a volcanic eruption, although in which part of the world it has occurred they had no other source of information than conjecture, and the remembrance of what had happened a number of years ago. In reference to this matter, our correspondent says:—"We have been much astonished here at a very extraordinary phenomenon which took place two nights ago—a great fall of dust which continued many hours. The men at the herring fishing describe it as being like a thick shower of snow-drift from the north-west. It began to fall before daylight, and continued very thick for a few hours, and afterwards more slightly till about mid-day. Those who had clothes out bleaching had them completely blackened, and it seems very difficult to wash off. The white flowers in the gardens are quite destroyed, and every "kail blade" is covered. The only way of accounting for it is by supposing that Mount Hecla has had an eruption, as the wind was exactly from that quarter, and it is quite evident the dust is volcanic. Dr Barry, in his history of Orkney, says, that in 1783, the last dreadful eruption of Mount Hecla, the dust fell here in the same manner, though it does seem surprising that it could be carried so far—upwards of 400 miles. It will be some time before we hear if an eruption has really taken place. The fishermen were so terrified at the uncommon and inexplicable sight, that several of them refused to go out to sea next day, and some believe it may have a slight effect on the herring trade.—*Edinburgh Advertiser.*

11. *Synopsis of the Carboniferous rocks of Pictou, Nova Scotia.*—1. *Newer Coal Formation.*—The prevailing rocks are alternations of reddish and grey sandstones and shales, with some coarse conglomerates, especially in the lower part. Subordinate to these are dark grey concretionary limestone, thin beds of coarse sandy limestone, two thin beds of coal and one of gypsum. Thickness, 5000 feet or more.

Fossils.—*Coniferous wood, Calamites, Ferns, &c., Ganoid fish, tracks of land animals.*

2. *Older Coal Formation.*—The prevailing rocks are dark shales and clays, grey and brown sandstones; and subordinate to these are coal, ironstone, dark limestone. Thickness, 5000 feet.

Fossils.—*Ferns, Stigmaria, Calamites, Lepidodendra, &c., Cypris.*

3. *Mountain Limestone or Gypsiferous Formation.*—The pre-

vailing rocks are reddish sandstones, shales, and clays, with some grey beds; conglomerates, especially in lower part; and subordinate to these, thick beds of limestone, thick beds of gypsum with anhydrite. Thickness, 6000 feet or more.

Fossils.—*Calamites, fragments of Carbonized plants, Producta, Terebratula, Encrinites, Madrepores, &c.*

Small quantities of copper ores are found in the sandstones in the gypsiferous and newer coal formations, especially in the latter. Salt springs rise from the older coal and gypsiferous formations in a few places. Veins of hematitic iron ore occur in the gypsiferous rocks of the East River. The strata of the two older members of the carboniferous system are more hardened and disturbed than the newer series, and contain beds of trap, which occur in no part of the newer coal formation, except the conglomerate at its base.—*J. Dawson, Esquire.—Proceedings of the Geological Society, January* 22. 1845.*

NEW PUBLICATIONS RECEIVED.

1. Travels in North America; with Geological Observations on the United States, Canada, and Nova Scotia. By Charles Lyell, Esq., F.R.S., &c., &c. 2 vols. 12mo. J. Murray, Albemarle Street, London. 1845. *The Geological Map of the United States, the original and communicated geological observations and descriptions, and the judicious and temperate views of the people and establishments of the United States, Canada, and Nova Scotia, have procured for these volumes a deservedly high reputation.*

2. Murray's Home and Colonial Library, Nos. XXII., XXIII., and XXIV., containing Journal of a Voyage round the World. By Charles Darwin, M.A., F.R.S., &c. J. Murray, Albemarle Street, London. 1845. *This is a much improved edition of Mr Darwin's well-known and truly delightful Journal of a Voyage round the World. From the many new and interesting additions made to it by the author, it cannot fail to have a very wide circulation among cultivators of science and general readers.*

3. Sur les Lignes d'Ancien Niveau de la Mer dans le Finmark. Par M. A. Bravais, Membre de la Commission Scientifique du Nord. *M. Bravais, one of the distinguished naturalists of the French Scientific Commission to the North, gives in this memoir a minute, accurate, and interesting*

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* Mr Dawson remarks, that the greater part of the rocks composing the newer coal formation of Pictou were formerly confounded, under the name of new red sandstone, with a part of the gypsiferous series, and with a deposit of non-fossiliferous red sandstone skirting the shores of the Bay of Funday, and unconformably superimposed on the older carboniferous strata. He adds, "I have no doubt, however, that in other parts of Nova Scotia the newer coal formation will be found to be a well-marked carboniferous group."

account of the lines of the ancient level of the sea as observed by him in Finmark.

4. The Chemistry of Vegetable and Animal Physiology. By Dr G. J. Mulder, Professor of Chemistry in the University of Utrecht. Translated by Dr Fromberg, with additions by Professor Johnston of Durham. Part 2. Blackwood and Sons, Edinburgh. *We are happy to announce the publication of Part 2 of Mulder's excellent work.*

5. Outline of the Geology of the Neighbourhood of Cheltenham. By R. I. Murchison, V.P.R.S., &c., &c. A new edition, augmented and revised by James Buckman, F.G.S., and H. E. Strickland, M.A., F.G.S. With numerous plates and a coloured geological map. 8vo, pp. 109. J. Murray, Albemarle Street, London. 1845. *Geologists and visitors to this celebrated watering-place will, we doubt not, feel grateful to Messrs Murchison, Buckman, and Strickland, for the pains they have bestowed on this beautiful and improved edition of the " Outline of the Geology of the Neighbourhood of Cheltenham."*

6. Die Versteinerungen von Kieslingswalda und Nachtrag zur Characteristik des Sächsisch-böhmischen Kreidegebirges, von Dr Hanns Bruno Geinitz. Mit 6 Steindrucktafeln. 4to, pp. 23. Dresden and Leipzig, Arnoldische Buchhandlung, 1843. *We recommend this well-illustrated volume to the notice of Palæontologists.*

7. Contributions to Vital Statistics. By F. G. P. Neison, F.L.S. 4to, pp. 148. Hugh Cunningham, Publisher, 193, Strand, London. 1845. *Vital Statistics, a subject of much and daily-increasing importance, will be benefited by Mr Neison's interesting work.*

8. Oratio ex Harveii Instituto in Ædibus Collegii Regalis Medicorum habita Die Junii xxv. MDCCCXLV. a Carolo Daubeny, M.D., Coll. Reg. Med. Lond., et Reg. Soc. Socio, Chemiæ et Botanices apud Oxonienses Professore. Oxonii : E Typographeo Academico, 1845, 4to, pp. 25.

9. The London Medical Directory, 1845. Containing the Names, Address, Qualification, Official Appointments, Honorary Distinctions, and Literary Productions, of every Physician, Surgeon, and General Practitioner, resident in London. 12mo, pp. 180. John Churchill, Princes Street, Soho, London, 1845.

10. New Statistical Account of Scotland, No. 51. Containing the conclusion of the County of Fife, &c. Published August 1845. Blackwood & Sons, Edinburgh, 1845. *This national work will be completed in October 1845.*

11. The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland, No. 9, New Series. Blackwood & Sons, Edinburgh and London, 1845.

12. Proceedings of the American Philosophical Society for June and July 1844.

13. Annalen der Physik und Chemie; Herausgegeben von J. C. Poggendorff zu Berlin. Up to No. 5, 1845.

14. Journal of the Asiatic Society of Bengal, up to No. 147. No. 63, New Series.

15. Bibliothèque Universelle de Genève. Up to No. 114, June 1845.

16. American Journal of Science and Arts. Conducted by Professor Silliman and Benjamin Silliman junior. Up to No. 1, July 1845.

17. Philosophical Transactions of the Royal Society of London, for the year 1844, Part 2; and for 1845, Part 1.

18. Transactions of the Royal Society of Edinburgh, vol. xvi., part 1, 1845. Also vol. xvii., part 1., containing the Mackerston Magnetical and Meteorological Observations.

19. An Elementary Treatise on Mineralogy. By William Phillips, F.L.S., &c. Republished in America, with numerous additions, by Francis Alger, Member of the American Academy of Sciences, &c. 8vo. pp. 662, with numerous figures. Ticknor & Co. Boston, 1844. *This edition of Phillips's Mineralogy, like the works of Dana, Shepard, &c., affords proof of the skill and acuteness of American Mineralogists.*[*]

10. Neues Jahrbuch für Mineralogie, Geognosie, Geologie, und Petrefactenkunde, Herausgegeben von Leonhard & Bronn. Up to Drittes Heft, Jahrgang 1845.

21. Uebersicht der Resultate Mineralogischer Forschungen im Jahre 1843. Von W. Haidinger. Mit. 1 Tafel. Not published until the year 1845. *This volume, which may be considered as a continuation of Glocker's Heften, abounds in good information on mineral species, and other mineralogical topics; we hope the accomplished author will continue to publish an annual volume.*

22. Die Sächsischen Erzgänge von Berghauptmann J. C. Freiesleben. Heft 1-2. 1843-1844. Freyberg, bei J. G. Engelhardt. *Freiesleben, the celebrated Saxon Berghauptmann, long distinguished as an excellent observer, communicates, in the work now before us, much interesting geognostical and mining information.*

23. Handbuch der Bestimmenden Mineralogie. Von W. Haidinger, K. K. Wirklichem Bergrath, &c., &c. One volume, 8vo, pp. 625. With numerous woodcuts. Wien. Bei Braumüller & Seidel. 1845. *In this work the talented author treats of the introductory parts of Mineralogy, and of the characteristic of Minerals. His classification is nearly that of his illustrious preceptor Mohs. M. Haidinger, with extraordinary means at his command, will, we hope, proceed without delay, with the important and beautiful part of his subject—namely, the Physiography of Minerals.*

24. Handbuch der Mineralogie, von Joh. Fried. Ludw. Hausmann, Königlich Hannoverschem Hofrathe und Professor zu Göttingen, &c., &c. Zweiter Theil. System und Geschichte der Mineral-Körper. Erste Abtheilung. Zweite gänzlich umgearbeitete Ausgabe. Göttingen, Vanden-

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[*] The copy of Alger's Mineralogy, although sent for this country by the author above a year ago, only reached us the other day.

hoeck und Ruprecht. 1845. 8vo, pp. 352. *The publication of the continuation of the second edition of the well-known Mineralogy of Professor Hausmann has been long anxiously expected: we, therefore, rejoice to have before us a part of the second division of the work, lately published. In this, as in the former division of the system, Hausmann's soundness of judgment and learning are very conspicuous.*

25. L'Institut, up to 10th August 1845.

26. Origin of the Constituent and Adventitious Minerals of Trap and the allied Rocks. By James D. Dana, Esq., Newhaven, United States. 1845.

27. Account of Blum's Treatise on Pseudomorphous Minerals; and Observations on Pseudomorphism. By J. D. Dana, Esq., Newhaven, United States. 1845.

28. Das Rheinische Uebergangsgebirge. Eine Palæontologisch-geognostische Darstellung. Von Carl Ferdinand Roemer, Dr Phil. Mit sechs lithographirten Tafeln; 4to. Hanover. 1844.

29. Bibliothèque Zoologique et Paléontologique. 3e Fascicule: H—S. inclus., Feuill. 107-251. Folio, Neuchatel, en Avril, 1844.

30. On the Drift-Ice and Currents of the Atlantic. By W. C. Redfield, Newhaven, United States. 1845. *Valuable, as is the case with all Mr Redfield's publications.*

31. Sixth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England. 8vo, pp. 666. London: Printed by W. Clowes & Sons. 1845. *A very important and admirably executed work.*

32. Comptes Rendus de l'Academie des Sciences, up to December 30. 1844.

33. Report of Lectures on the Natural History of Plants yielding Food, delivered by Edwin Lankester, M.D., &c. Published by John Churchill, 46 Princes Street, Soho.

34. The Twelfth Annual Report of the Royal Cornwall Polytechnic Society, 1844.

35. A series of Memoirs by M. Descloizeaux on the following subjects, viz.:—On the Crystalline forms of Gay-Lussite; On Æschynite; On some Crystalline forms of Apatite; On Ottrelite; On Monazite; On the primitive and secondary forms of Gypsum; On the union of Neoctese with Scorodite; On the crystalline forms of Anatase; On the crystalline forms of Realgar; On Pennine, &c.; On the primitive form of Humboldtilite; On the crystalline forms of Greenockite; On the crystalline forms of Cymophane; On the crystalline forms of Perowskite; On the crystalline forms of five varieties of Arseniate of Copper; On two varieties of Baryto-Calcite; On a new twin-crystal of Rutile. *These Memoirs were presented to us by the distinguished author when on a visit to Edinburgh, after his voyage to Iceland, Faroe Isles, and Orkney Isles.*

List of Patents granted for Scotland, from 12*th June to* 22*d September* 1845.

1. To Joseph Quick of Sumner Street, Southwark, in the county of Surrey, engineer,—" an improvement in steam-engines."—12th June 1845.

2. To Joseph Washington Tyson of Burton Crescent, in the county of Middlesex, Esquire, being a communication from abroad,—" improvements in fire-arms and ordnance."—12th June 1845.

3. To John Dewrance of Liverpool, in the county of Lancaster, engineer,—" certain improvements in steam boilers, and in the construction, composition, and manufacture of bearings, steps, and other rubbing surfaces of steam-engines and other machinery, and also for a method of lubricating the same."—16th June 1845.

4. To Warren-de la-Rue of Bunhill Row, in the county of Middlesex, manufacturer,—" improvements in covering the surfaces of paper and other materials with color and other substances."—17th June 1845.

5. Henry Whiting of Southwark Bridge Road, in the county of Surrey, hatter's furrier, being a communication from abroad,—" certain improvements in machinery or apparatus for shaping the brims of hats." —17th June 1845.

6. To Laurence Hill junior, of the city of Glasgow, in the county of Lanark, in Scotland, civil and mechanical engineer,—" an improved brake for railway carriages."—19th June 1845.

7. To David Henderson of London Works, Renfrew, in the county of Renfrew, civil-engineer,—" certain improvements in cranes."—19th June 1845.

8. To Robert Addison of Regent Street, in the county of Middlesex, piano-forte manufacturer, being a communication from abroad,—" improvements in piano-fortes."—23d June 1845.

9. To Charles Smith of No. 13 Newcastle Street, Strand, in the county of Middlesex, gentleman,—" new and improved methods in the construction and application of a variety of cooking, culinary and domestic articles and utensils, some of which are applicable to cleaning, and a variety of similar useful purposes."—24th June 1845.

10. To James Johnston of Willow Park, Greenock, Esquire —" new and improved processes, and machinery for making and refining sugar."— 26th June 1845.

11. To Auguste Cherot of Nantes, in the kingdom of France, spinner, being a communication from abroad,—" certain improvements in machinery for spinning flax, hemp, and other fibrous materials."—30th June 1845.

12. To Charles Wheatstone of Conduit Street, in the county of Middlesex, Esquire, and William Fothergill Cooke of Kidbrooke, near Blackheath, in the county of Kent, Esquire,—" improvements in electric telegraphs, and in apparatus relating thereto, part of which improvements are applicable to other purposes."—3d July 1845.

13. To David Gavin Scott, residing at Cromwell Park, in the county of Perth, Scotland, being a communication from abroad,—" an

invention by which the heddles of a loom are moved to produce various patterns on woven fabrics."—4th July 1845.

14. To JAMES KITE of Hoxton, in the county of Middlesex, coal-merchant,—"certain improvements in constructing chimneys, and in the means used for sweeping the same, parts of which improvements are applicable to other like useful purposes."—7th July 1845.

15. To PATRICK SANDEMAN of Greenside Place, Edinburgh, upholsterer,—"improvements on coffins."—9th July 1845.

16. To WILLIAM MATHER and COLIN MATHER of Salford, in the county of Lancaster, engineers,—"certain improvements in boring earth, stone, and subterraneous matter, and in the machinery, tools, or apparatus, applicable to the same."—15th July 1845.

17. To HENRY PINKUS of 36 Mount Street, Grosvenor Square, in the county of Middlesex, Esquire,—"improvements in obtaining and applying motive power to impelling machinery."—17th July 1845.

18. To JOSEPH AMESBURY of Devonshire Street, Portland Place, surgeon,—"improvements in apparatus for the relief or correction of stiffness, weakness, or distortion in the human body."—18th July 1845.

19. To THOMAS WILLIAM GILBERT of Limehouse, in the county of Middlesex, sail-maker,—"improvements in the construction of sails for ships and other vessels."—18th July 1845.

20. To ALEXANDER WRIGHT of South Lambeth, in the county of Surrey,—"improvements in gas-meters."—21st July 1845.

21. To THOMAS GRUBB of Dublin, in the county of Dublin, civil-engineer,—"improvements in bank notes, and in machinery connected therewith, parts of which are also applicable to cheques, bills, and other documents."—23d July 1845.

22. To WILLIAM YATES of Manchester, in the county of Lancaster, upholsterer, and DENIS DOLAN of the same place, scagliola-manufacturer,—"certain improvements in plastic manufacture or composition. part of which is applicable to decorative and useful purposes, and part as a fire-proof cement or plaster."—28th July 1845.

23. To WILLIAM SHAW of Canning Place, Liverpool, in the county of Lancaster, printer and account-book manufacturer,—"a machine for paging books and numbering documents consecutively, and otherwise, and for printing dates, words, marks, numbers, or impressions, in an expeditious manner."—29th July 1845.

24. To ISHAM BAGGS of Great Percy Street, Claremont Square, in the county of Middlesex, engineer,—"improvements in obtaining motive power by air."—29th July 1845.

25. WILLIAM POLLARD of Newcastle-upon-Tyne, gentleman,—"certain improvements in the production of combustible gases, and in the application of the same as fuel."—30th July 1845.

26. RICHARD SIMPSON of the Strand, London, gentleman, being a communication from abroad,—"certain improvements in bleaching yarns and fabrics."—31st July 1845.

27. To WILLIAM GEORGE HENRY TAUNTON of Liverpool, in the county of Lancaster, civil-engineer,—"certain improvements in machinary for revolving windlasses, barrels, spindles, shafts, and for pumping."—31st July 1845.

28. To WILLIAM HANNIS TAYLOR of Piccadilly, in the county of

Middlesex, gentleman, and Thomas Bartlett Simpson of Great Russell Street, in the same county, gentleman,—"certain improvements in propelling."—5th August 1845.

29. To Thomas Clarendon of No. 213 Great Brunswick Street, in the city of Dublin, gentleman, being a communication from abroad,—"an improved method of shoeing horses and other beasts of burden."—5th August 1845.

30. To John Macintosh of Glasgow, gentleman,—"improvements in preparing materials for colouring and printing calicoes and other fabrics, and improvements in printing and ornamenting fabrics."—6th August 1845.

31. To Alexander Wilson of Glasgow, in the county of Lanark, manager for Alexander Fletcher and Co., flax-spinners, Glasgow,—"improvements in spinning hemp and flax, and other fibrous materials." 6th August 1845.

32. To John Parsons of No. 2 Stone's Row, Saint Pancras, in the county of Middlesex, machinist,—"certain improvements in the manufacture of fuel, and in apparatus for the use of the same."—8th August 1845.

33. To Frederick Herbert Maberly of Stowmarket, in the county of Suffolk, clerk, master of arts,—"certain improvements in machinery, or the apparatus for stopping or retarding railway or other carriages, applicable also for these purposes in regard to other engines or wheels."—8th August 1845.

34. To Elias Robison Handcock of No. 16 Regent Street, in the county of Middlesex, Esquire,—"certain improvements in mechanism, applicable to turn-tables for changing the position of carriages and engines on railways, which improvements are also applicable to cranes and other purposes."—8th August 1845.

35. To William Young of Paisley, manufacturer and dyer, and Archibald M'Nair of the same town, merchant,—"certain improvements in the construction and means of manufacturing apparatus for conducting electricity."—12th August 1845.

36. To George Bell of Pembroke Road, in the city of Dublin, merchant,—"certain improvements in drying malt, grain, and seeds."—12th August 1845.

37. To Hugh Cogan, merchant and manufacturer, of West George Street, Glasgow, in the county of Lanark,—"an improved method or methods for weaving in patterns, or various colours, or fabrics."—20th August 1845.

38. To William Newton of the Office for Patents, No. 66 Chancery Lane, in the county of Middlesex, civil-engineer, being a communication from abroad,—"improvements in machinery to be employed in the manufacturing of nails, rivets, screws, and pins."—20th August 1845.

39. To James Ivers of Preston, in the county of Lancaster, machine-maker,—"certain improvements in machinery, or apparatus for preparing, roving, and slubbing, cotton, wool, and other fibrous substances."—21st August 1845.

40. To William Breynton of the Inner Temple, in the city of London, Esquire,—"certain improvements in rotatory steam-engines. and in the means of working the same."—21st August 1845.

41. To William Eccles and Henry Brierly, both of the township of Walton-le-dale, in the parish of Blackburn, in the county palatine of Lancaster,—"improvements in the machinery or apparatus used in spinning."—21st August 1845.

42. To George Myers of Laurie Terrace, Westminster Road, Lambeth, builder,—"improvements in cutting or carving wood, stone, and other materials."—27th August 1845.

43. To Jacob Brett of Hanover Square, in the county of Middlesex, Esquire, being a communication from abroad,—"improvements in printing communications made by electric telegraphs."—27th August 1845.

44. To Joseph Zambaux, chemist, of Paris, in the kingdom of France,—"improvements in atmospheric railways."—8th September 1845.

45. To John Cox and George Cox of Gorgie Mills, county of Edinburgh, tanners and glue-makers,—"improvements in tanning and leather dressing."—8th September 1845.

46. To Hypolite Louis Francois Salembier of Mincing Lane, in the city of London, merchant, being a communication from abroad,—"improvements in the manufacture and refining of sugar."—8th September 1845.

47. To William Edward Newton of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, being a communication from abroad,—"improvements in machinery or apparatus for spinning."—8th September 1845.

48. To William Wylam of Gateshead, in the county of Durham, Esquire,—"certain improvements in artificial fuel, and in machinery for manufacturing the same."—16th September 1845.

49. To John Russell of the city of Edinburgh, accountant,—"a manufacture of glass tiles."—16th September 1845.

50. To Edwin Hill of Bruce Castle, in the county of Middlesex, gentleman, and Warren-de-la-Rue, of Bunhill Row, in the county of Middlesex, manufacturer,—"improvements in the manufacture of envelopes."—19th September 1845.

51. To Jacob Brett of Hanover Square, in the county of Middlesex, gentleman, being a communication from abroad,—"improvements in atmospheric propulsion, and in the manufacture of tubes for atmospheric railways and other purposes."—19th September 1845.

52. To James Hardcastle of Firwood, Bolton-le-Moors, in the county of Lancaster, Esquire,—"certain improvements in the method of conveying water."—22d September 1845.

The following were omitted, by mistake, in the List of Patents contained in No. 77:—

To Thomas Russell of Kirkaldy, in the county of Fife, iron-founder, and John Peter junior, of Kirkland Works, in the same county,—"certain improvements in flax-spinning and flax-spinning machinery, which are also applicable to the manufacture of other fibrous substances."—8th May 1845.

To James Lamb Hancock, Frederick Augustus Lamb Hancock, and William Lamb Hancock, of the parish of Guildsford, in the county of Montgomery,—"an improved rotatory steam-engine."—13th May 1845.

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